Washington State Department of Health

Guidelines for the Use of Pressure Distribution Systems

July 1996

Environmental Health Programs

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I. Technical Review Committee -- Purpose and Function

The Washington State Board of Health has developed rules and regulations for On-Site Sewage Disposal Systems (WAC 246-272, On-Site Sewage systems). This chapter of the Washington Administrative Code provides for the establishment and maintenance of an on-site sewage technical review committee. This 9 member committee provides technical advice to the department, and reviews and evaluates alternative sewage treatment and disposal systems. The TRC also reviews and advises the department on guidelines for the use of alternative systems. It is composed of technically qualified persons selected from various segments of the on-site sewage industry. Members may be from: private engineering and contracting firms, land sales, development and building industries, local health departments, public sewer utilities, the Washington State Department of Ecology, and/or other interested organizations. The On-Site Sewage Technical Review Committee plays a major part in the local health department support activities of the Department of Health, Environmental Health Programs.

Once guidelines are developed for a general class or type of alternative system or system component, such alternative approaches may be permitted by the local health agency. Proprietary devices or methods must be evaluated by DOH and certified by the proprietor or their representative that it satisfies all criteria in the appropriate guidelines. This certification is required before the device is included on the List of Approved Systems and Devices as an approved alternative on-site sewage treatment and disposal system proprietary device.

II. Preface

This document is intended to serve three functions:

1. As a Design Guide, it provides the necessary minimal parameters for the design of pressure distribution component within an on-site system.

2. As a Review Guide, it aids the regulator by providing consistent minimum requirements as well as suggested specific methodology. An example and useful tables are contained in the appendices.

3. As a Quality Control Guide, it provides uniform and consistent design logic that produces high quality, easily managed and monitored, pressure distribution components for on-site sewage disposal systems.

These guidelines are to be used in conjunction and compliance with the rules and regulations for on-site sewage systems (WAC 246-272) and any local regulations that apply.

Throughout the document various terms are used to describe the "degree of importance" of variable design aspects. These words are:

May:	Optional; but consider this approach.
Should:	Optional; but good or accepted practice as presented, a wise or prudent choice.
Must:	Not optional; good or accepted design practice, mandates use as presented.

III. Introduction

Research evidence indicates that wastewater traveling vertically through 2-4 feet of unsaturated soil provides adequate treatment of wastewater. Research also indicates that the method of distribution of septic tank effluent within the soil absorption field can affect the system's treatment performance. Uniform distribution delivers effluent such that each square foot of bottom area receives approximately the same amount per dose.

The most commonly used method for distributing effluent is gravity flow. Gravity flow allows wastewater to flow by gravity through large diameter pipes into the absorption field. Distribution is usually localized in a few areas within the field, which results in overloading of the infiltrative surface in those areas. This overloading can lead to groundwater contamination in coarse granular soils due to insufficient treatment, or more rapid clogging in finer textured soils.

A second method of distribution, dosing, can overcome some of these problems. It is dealt with in a separate publication entitled, Guidelines for Alternating and Dosing Systems, revised July 1984. Because effluent is distributed over a larger portion of the absorption area and the period between doses is maximized, the degree of soil clogging is reduced. However, localized overloading may still occur.

A third method, pressure distribution, is most successful in solving these problems by applying effluent uniformly over the entire absorption area at a rate less than the saturated hydraulic conductivity of the soil. This process promotes soil treatment performance by maintaining vertical unsaturated flow at all times and also reduces the degree of clogging in finer textured soils. Pressure distribution closely approaches uniform distribution.

A pressure distribution system consists of small 1-2 inch diameter laterals with small discharge orifices, and a means to deliver specified doses of effluent to the drainfield or treatment unit under pressure (Converse, 1974; Converse, et al., 1975; Otis, et al., 1978). A pressure head is created within the small diameter, perforated pipe, usually by means of a pump or siphon. The result is more uniform distribution throughout the system.

Pressure distribution is applicable to any system which uses soil as a treatment medium and may improve long term performance of those systems. It is required by WAC 246-272 for certain site and soil conditions. Since pressure distribution is a required component for mounds and sand filters, the design and use of the pressure distribution component for these systems must follow these guidelines.

Pressure distribution is usually used in locations where it is either desirable or required to:

1. achieve uniform application throughout the drainfield area;

2. treat and dispose of effluent higher in the soil profile;

3. avoid potential contamination of ground water beneath excessively permeable soils;

4. improve the treatment performance and extend the life expectancy of a drainfield or other component; and

5. reduce the potential for breakout or seepage on slopes.

Pressure distribution is appropriate for sites in aquifer sensitive areas, for sites with limited soil depth, and for larger drainfield systems. Finally, in certain conditions where pumping is necessary due to elevation problems, pressure distribution can be incorporated with little additional expense.

IV. General Requirements

A. Basic Design Rules

1. Design Intent

As the intent of pressure distribution is uniform distribution, this will be the major performance criterion which the system must pass before it is placed into service.

To pass, the system must meet the following criteria:

a. the variation in orifice discharge rates within any one lateral must not be more than 10%;

b. the variation in orifice discharge rates over the entire distribution system must not be more than 15%;

c. an additional test for equal distribution is needed which takes into consideration unequal flows during system pressurization and during draindown after the pressure cycle. Therefore, for laterals at different elevations, the volume of liquid from an orifice (same size as the others in the laterals) placed in a plug or cap in the end of each lateral must be collected and measured. The variation between the largest volume and the least volume collected must not be more than 15%.

d. A minimum residual pressure of 0.87 psi (2 feet of head) is required for systems with 3/16 inch diameter orifices and larger, and 2.18 psi (5 feet of head) is required for systems with orifices smaller than 3/16 inch.

2. Orifice Size and Spacing

It is strongly recommended that the distribution system have the same orifice size and orifice spacing throughout.

Equal distribution of liquid can be achieved by means of flow control valves or in-line flow control orifices installed at the head of each lateral. Such designs allow field correction of flow variations caused by conditions and construction details not foreseen by the system designer. In addition, constant orifice size and spacing facilitates maintenance and repair, including rebalancing the system after the laterals are flushed. Variable orifice sizing and spacing may be allowed with adequate engineering justification and with design features that allow ease of access and ability to provide maintenance.

3. General Recommendations

A rough test for adequate dose volume is that it should be at least 7 times the volume of the manifold, lateral piping and transport pipe which drains into the lateral trenches between doses. This calculation ensures that the distribution network is pressurized for most of the total dosing cycle.

Septic tanks, pump chambers and tight line connections must be water tight.

All on-site sewage treatment and disposal systems, including pressure distribution systems, should take into account the water use patterns of the occupants and the type of fixtures and equipment in the facility.

As with any drainfield, the bottom of the trenches must be level, the sides and bottom of the trench must not be smeared, and in gravel-filled trenches and beds, an acceptable geotextile shall be used on top of the gravel before backfilling.

System configuration - In general, pressure distribution systems on sloping ground should be as long and narrow as possible in order to minimize the potential for hydraulic overloading and ground water mounding. This is particularly important when soil depth is limited. On sloping sites the laterals must run parallel to the natural ground contours.

Transport pipes to pressure drainfields and mounds should be laid upslope from the distribution area to prevent preferential flows along the disturbed soil in the trench for the transport pipe.

4. O & M Design Features

The entire system shall be designed and built with the ability to provide maintenance. Examples of such design aspects include:

- risers over access ports for the pump chamber brought to or above grade;
- a screening device for septic tank effluent that is simple and easy to maintain;
- ends of laterals turned up and accessible from the surface, preferably in monitoring ports;
- control panels are convenient, well laid out, completely labeled; and,
- Operation & Maintenance manuals are complete and made available to the homeowner and the local health department.

5. Dosing Frequency

A system of timed doses is <u>strongly recommended</u> on all pressure distribution systems. Timed dosing is required on all sand filters, mounds, pressure distribution systems in soil types 1A, 1B, 2A, and 2B, and on all systems larger than 1000 gallons per day. See section on pump controls for further discussion.

The minimum design dosing frequency for various soil types should follow these recommendations:

Soil Type 1A	Greater than 4 times per day
Soil Types 1B, 2A, 2B, and 3	Four times per day
Soil Types 4-6	One to two times per day.

More frequent doses than those recommended above may be desirable in some designs. Dosing of drainfields provides intermittent aeration to the infiltrative surface. With this method, periods of loading are followed by periods of resting, with cycle intervals ranging from hours, to a day or more. The resting phase should be sufficiently long to allow the system to drain and expose the infiltrative surface to air, which encourages degradation of the clogging materials by aerobic bacteria. In sands, however, the rapid infiltration rates can lead to bacterial and viral contamination of shallow ground water, especially when first put into use. Therefore, systems constructed in these soils should be dosed with small volumes of wastewater four or more times a day to prevent saturated conditions from occurring and hence, inadequate treatment. In finer textured soils, saturated flow is much less likely, so frequent doses do not add to the performance. Large, less frequent doses are more suitable in these soils to provide longer aeration times between doses (EPA, et al).

B. Minimum Design Submittal

A completed design must include the following as a minimum:

1. a detailed schematic drawing of the proposed system
2. daily design flow
3. septic tank size, location and outlet invert elevation
4. pump pickup elevation and location, or siphon invert elevation and location
5. size of pump or siphon chamber
6. transport line length, location, highest elevation, and diameter
7. all valves or other such components in the system
8. manifold diameter, location, length, and orientation
9. lateral diameter, location, length, orientation, and elevations
10. orifice diameter, spacing, and orientation
11. dose volume, pumping rate (gpm), dose frequency, and design residual pressure
12. location and detail of access ports on the laterals
13. detail of pump controls, floats, and the position of the floats
14. an electrical schematic specific to the project
15. system parameters and calculations used by the designer to arrive at the component sizing and flow distribution shown in the design
16. a users manual for the pressure distribution system must be developed and provided to the homeowner and the local health department. See Appendix F for a list of items to be included in the manual.

C. Minimum As-built Information

A completed as-built submission must contain, at a minimum, the following items:

1. all the items contained in the design submittal listed above, as installed, identifying any changes from the approved plan.

2. the measured drawdown per dose cycle

3. timer functions

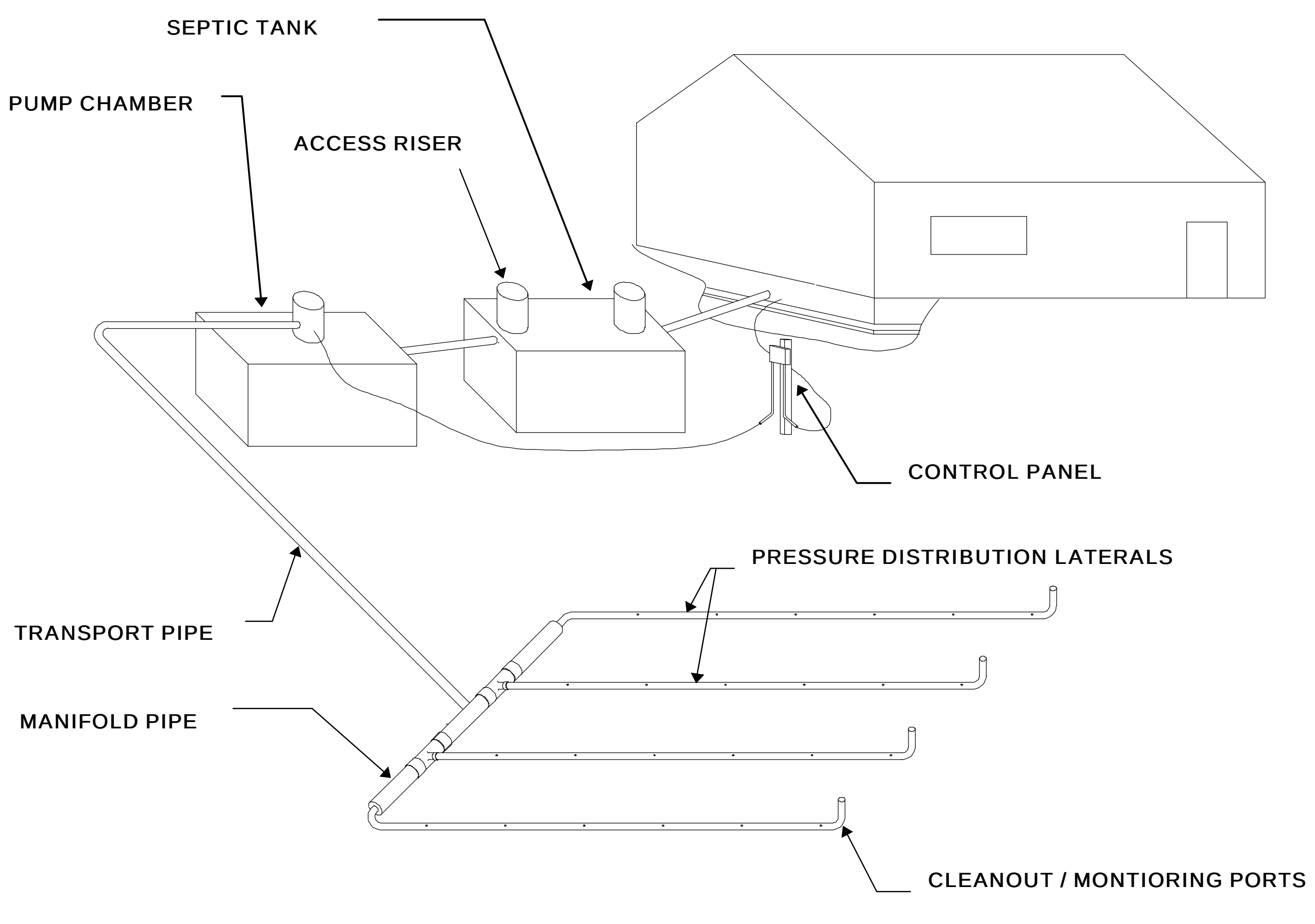
4. residual head and/or squirt height at the end of each lateral, as inspected;

5. pump run time and pump time off.

V. Description of System Components

Figure 1 illustrates the major components of a typical pressure distribution system.

Component	Primary Function
Septic tank	Solids separation and storage, with facultative decomposition
Pump chamber	Transport a specific volume of effluent from the pump chamber to the distribution network. Accumulate effluent between pump cycles and during malfunction.
Transport line	Pipeline which connects the pump to the drainfield manifold.
Manifold	Piping network connecting the transport line to the various laterals.
Laterals	Small diameter pipes with orifices which distribute effluent within a trench or bed.
Drainfield	Allows the septic tank effluent to pass into the native soil or other receiving media where various biological and physical processes provide additional treatment.



PRESSURE DISTRIBUTION
DRAINFIELD

FIGURE 1

VI. Septic Tank

All septic tanks must be designed in compliance with Washington State On-Site Sewage System Regulations (WAC 246-272-11501(2)(d)) and with the Department of Health's Design and Construction Standards for On-site Wastewater System Tanks. Until the tank standards are available, all septic tanks must also:

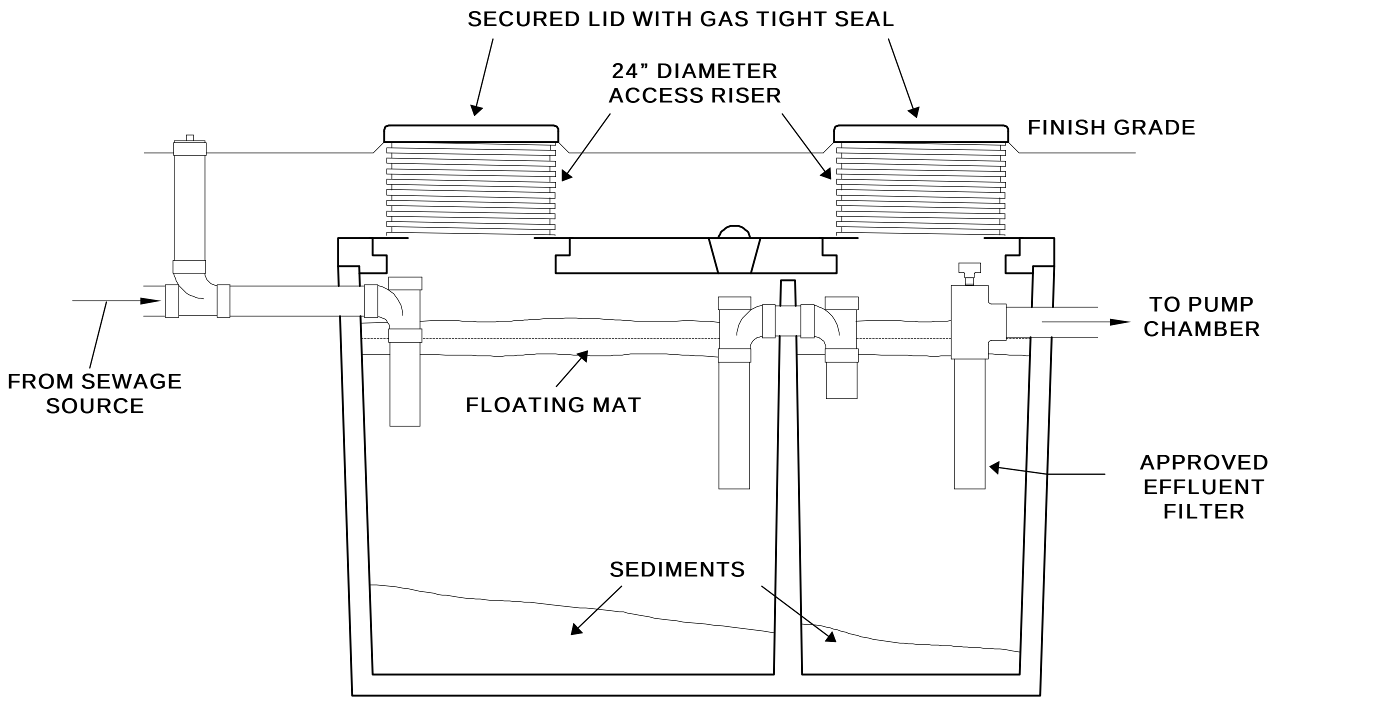
A. be watertight to a level above any possible seasonal ground water. Leak testing may be required.

B. be equipped, for each compartment of the septic tank, with a minimum 24 inch diameter, water tight, secured (bolts or equivalent) access riser that extends to the ground surface. If risers extend through regions of possible high seasonal ground water, water tightness testing of the riser may also be required to the maximum seasonal ground water level. Riser lids should be equipped with air-tight gaskets to eliminate nuisance odors.

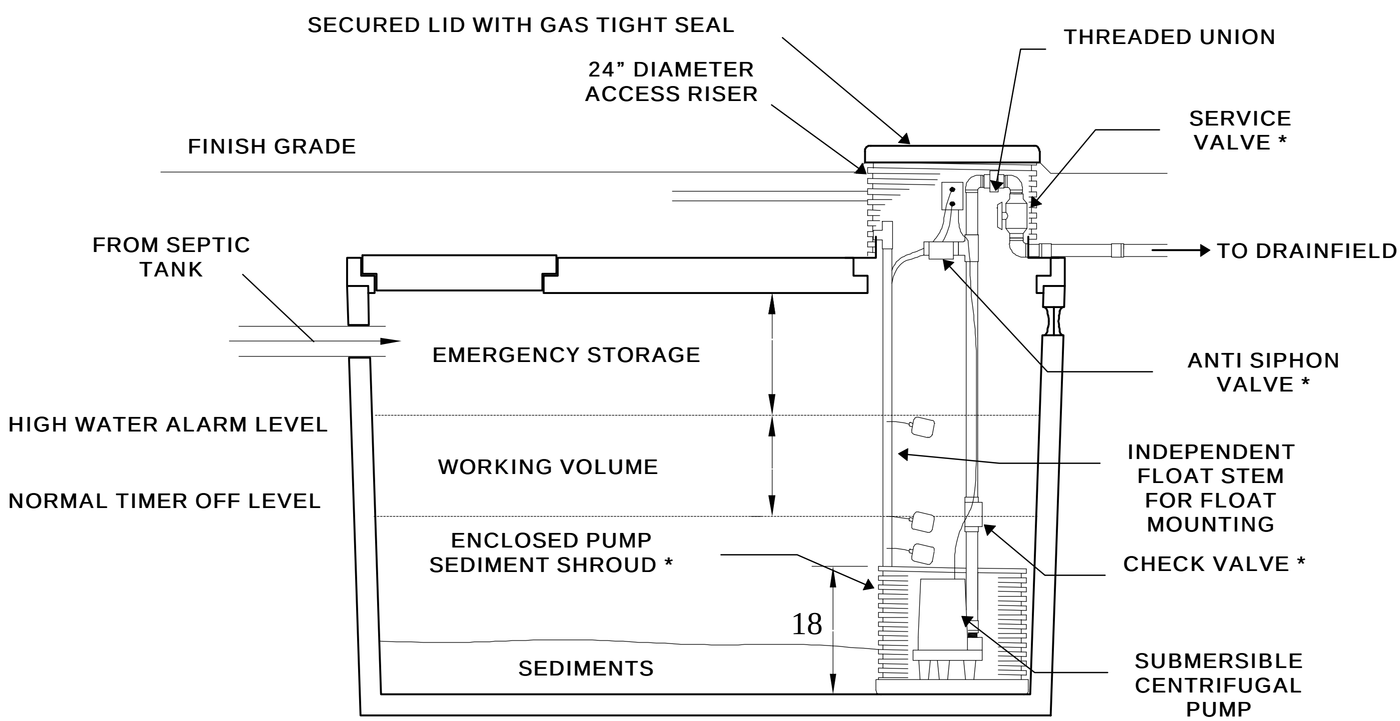
C. include screening of the effluent. Effluent screening is beneficial by improving the quality of the wastewater and preventing the pumping of solids into the small diameter distribution system. Therefore, the effluent must be screened before entering the pump or siphon intake. The preferred method of screening is with a baffle screen or filter at the outlet of the septic tank or other pretreatment device. It is preferred because the flow rate is low and therefore will yield a higher quality effluent. If an effluent baffle screen is not used, then a screening device must be provided in the pump tank (see Section VII,A,4).

An outlet baffle screen or filter must meet the following minimum criteria:

- maximum mesh opening of 1/8 inch
- non-corrosive material
- provide an open area flow capacity at least equal to the flow capacity provided by a 4" diameter PVC pipe *[Note: This minimum area will very likely require a high frequency of cleaning and in standard practice a much larger flow area is used. The larger flow areas will result in longer intervals between services for the same hydraulic and organic strength loadings.]*
- the screen must be securely fastened to prevent dislodging or misalignment
- be easily removable and/or designed, constructed and installed for easy and thorough cleaning
- draw liquid from the "clear zone" of the septic tank (the zone between 40% down from the top of the liquid and 40% up from the bottom of the tank)
- be capped, covered or otherwise constructed to prevent scum or other floatable solids from discharging from the tank by bypassing the screen or filter.



SEPTIC TANK
(TYPICAL)



PUMP CHAMBER
(TYPICAL)

* AS NEEDED

FIGURE 2

VII. Pump Chamber, Pump, and Controls

A. Pump Chamber Requirements:

All pump chambers must be structurally sound and conform to Washington State On-Site Sewage System Regulations (WAC 246-272-11501) and with the Department of Health's Design and Construction Standards for On-site Wastewater System Tanks. Until the tank standards are available, all pump chambers must also:

1. be water tight to a level above any possible seasonal ground water. Leak testing may be required.

2. all pump chambers must be equipped with a twenty-four (24) inch minimum diameter, water tight riser with a secured lid that extends to the ground surface. Lids should be equipped with an airtight gasket to eliminate nuisance odors.

3. the internal volume of the pump chamber shall be sufficient to provide the **daily design flow volume**, dead space below the pump inlet for sludge accumulation, and sufficient depth to provide full time pump submergence, when required. Additional space, (**emergency storage**) is required for storage during periods of power interruptions or malfunctions (emergency storage may include volume to flood capacity in both the pump tank and the septic tank). Emergency storage is defined as 75% of the daily design flow.

   See Figure 2.

   Some sites can be served by a pump vault in a single compartment septic tank. In addition to meeting the same requirements for screening, total volume, and effluent quality as for a separate pump chamber, there are special criteria and limitations that must be met when using this combination of septic tank and pump vault. A full description and delineation of requirements for this type of system are contained in Appendix E of this guideline.

   For systems where continuous operation and maintenance are provided by a management entity acceptable to the local health department, a reduction in the volume required for reserve storage may be considered. Reductions in pump chamber volume may also be considered when "Duplex" or redundant pumps are used.

4. include a screen if one is not provided at the outlet of the septic tank. **It should be noted again, that screening around the pump or siphon is not the preferred method** (see section VI,C)**.** If this method is selected it

should only be because screening at the septic tank outlet is impossible or impractical. It also means that the pump discharge rate shall be limited to 30 gpm or less, as rates greater than 30 gpm are known to lower effluent quality. [Note: 30 gpm maximum limit does not apply if screening is also at the septic tank outlet, and screening around the pump is for additional assurance or by requirement of the pump warranty.] The pump screen must meet the following minimum criteria:

- maximum mesh opening of 1/8"
- non-corrosive material
- a minimum of 12 square feet of wetted surface area
- cannot interfere with switches or floats
- should be easily removable for thorough cleaning

B. Pumps, Fittings and Controls Requirements:

Pumps must be selected to pump effluent and be capable of meeting the minimum hydraulic flow and head requirements of the proposed on-site system. Additional requirements that pumps and pump installations must meet are:

1. Pumps:

a. All pumps must be installed so that they can be easily removed and/or replaced from the ground surface. *(Under no circumstances should pump replacement and/or repair require service personnel to enter the pump tank).*

To allow easy pump removal, all pumps should be fitted with unions and valves necessary for this purpose. In addition, pumps and controls shall have gas-tight junction boxes or splices and have electrical disconnects (as per National Electric Code) appropriate for the installation. All pumps must be protected by approved outlet baffle screens in the chamber preceding the pump chamber or by pump screens, as described above.

b. Pumps and electrical hook-ups shall conform to all state and local electrical codes.

c. If a check valve is used in the system, a vent hole should be installed so the pump volute is kept filled with effluent. Some pumps may cavitate if the impeller is not kept submerged. Under most circumstances this hole will be needed only when the chamber is first filled with liquid or after it has been cleaned.

d. If any portion of the pump fittings or transport line is at a higher elevation than the drainfield, the system must be equipped with an air vacuum release valve or other suitable device to avoid siphoning.

2. Pump Controls:

a. A system of timed doses is <u>strongly recommended</u> on all pressure distribution systems. Timed dosing enhances performance, reliability, and protection from abuse. Timed dosing is required on all sand filters, mounds, pressure distribution systems in soil types 1A, 1B, 2A, and 2B, and on pressure distribution systems larger than 1000 gpd. *[Timed dosing is not required for pressure distribution drainfields following intermittent sand filters. The flow is already time-dosed to the sand filter, and therefore the pump chamber out of the sand filter may be demand-dosed. In this case, an elapsed time meter is required to monitor the integrity of the liner.]* These requirements and recommendations are based on the need to control the size of doses to the coarser and single grained soils and treatment media. Timed dosing also prevents hydraulic overload of the treatment and disposal components. Usual sources of hydraulic overload are excessive water use in the facility or groundwater infiltration into the septic tank or pump chamber.

Timed dosing means that both the length of each dose (produces gallons per dose) and the interval between doses (which determines the number of doses per day) is controlled by a timing device whenever a dose volume is in the pump chamber. The number of pump cycles must be adjustable and in sufficient number to meet the design needs of the system.

b. The preferred device for control is a panel specifically designed for on-site applications and is certified by an approved listing agency, e.g. Underwriters Laboratories (UL) or equivalent. If a panel is not used, then at a minimum, all pressure distribution systems shall include an electrical control system that:

- will meet the functional and reliability requirements for pressure distribution and be designed so that the distribution network receives the septic tank effluent evenly over a 24 hour period.

- assures no more than the design volume for each 24 hour period is delivered to protect the receiving component from hydraulic overload. A demand float system by itself will not do this

- has controls that are listed by UL or equivalent.

- is secure from tampering and resistant to weather and corrosion (minimum of NEMA 4).

- located outside, within line of sight of the pump chamber

c. As the number of dose cycles increases, the amount of effluent delivered per dose must decrease (in order to prevent more than daily design dose from being delivered to the drainfield). Delivering more than 6 or 8 doses per 24 hours will require one or more of the following features to be designed into the system:

- orifices at 12:00 o'clock to keep the piping network full or mostly full of effluent between doses (to reduce the volume per dose)

- transport, manifold and lateral pipe diameters are reduced (to reduce the volume per dose)

- orifice size is reduced (to reduce the volume per dose)

- fluid velocity in pipes is increased (to help scour the pipe and as a consequence of the reduced pipe size)

- residual hydraulic head at the orifices is increased (to help clear the smaller orifices)

- check valves are placed into the system to prevent flowback (to reduce the volume per dose)

A discussion on the advantages and disadvantages of demand float systems, time dosed systems and reduced dose volumes is contained in Appendix A.

d. All control panels must be capable of accommodating cycle counters and hour meters for all pumps.

e All control panels must be equipped with both audible and visual high liquid level alarms, placed in a conspicuous location.

f. The minimum requirements for timed pump cycle controls are a timer actuator float for the pump and a high liquid level alarm. In addition, a low liquid level off float is highly recommended. [See next section, Floats, for a discussion.] Float switches must be mounted independent of the pump and fittings so that they can be easily replaced and/or adjusted without removing the pump.

g. Electrical control and other electrical components must be approved by Underwriters Laboratories (UL) or equivalent.

h. Other standards that engineers, designers and installers need to be aware of and comply with are electrical standards for pump and control systems established by Washington State Department of Labor and Industries.

I. A control box or panel installed on a treated 4” X 4” post is acceptable practice and does not produce irritating resonations for the building occupants as occurs when the control panel is mounted on buildings.

3. Floats:

For pump chambers serving single family residences, two floats are necessary: a timer actuator float and a high water alarm float (“redundant off” controls are not required). However, a redundant off float and control circuit serve several very desirable functions not related to an explosive environment and are therefore <u>highly recommended</u>. Properly wired and tied to an alarm, the redundant off float and control circuit will turn off the pump at low liquid level even when the pump is operating with the manual switch. In addition, an alarm will be activated. In this way, the redundant off control / float will protect the pump from homeowner tampering, from a leaking pump chamber, from siphoning through the pump discharge pipe, and from any other situation where there is insufficient liquid volume in the pump chamber. Commercial and multi-family applications are required to meet Washington State Department of Labor and Industries requirements for Class I, Division I locations. These locations include redundant off and special ratings on installed motors and equipment.

C. Siphons:

Siphon systems do not offer the flexibility of pump systems. Since they are flow dependent they cannot provide timed doses, nor limit the daily volume. Therefore they are not a method of choice for pressure distribution where electricity is available. However, some locations may lend themselves to the use of siphons where a small pump delivers effluent to a distant siphon chamber, and then the siphon produces the velocity and flows to achieve uniform distribution. See Appendix B for specific requirements and for a discussion about the advantages and disadvantages of siphons.

VIII. Piping Materials

The pipe materials must meet the following minimum specifications:

A. For pipe sizes ≤ 2 inch, the material must meet ASTM D2241 Class 200 or equivalent.

B. For pipe sizes > 2 inch, the material must meet ASTM D2241 Class 160 or equivalent.

C. For schedule 40 and schedule 80 PVC, use ASTM D1785.

IX. Manifold

The primary function of the manifold is to deliver equal flow to all lateral orifices while minimizing system friction losses. While manifold patterns may take many forms, the most common are the center and the end manifolds. End manifolds suffice for short laterals but center manifolds allow for use of smaller lateral pipe sizes.

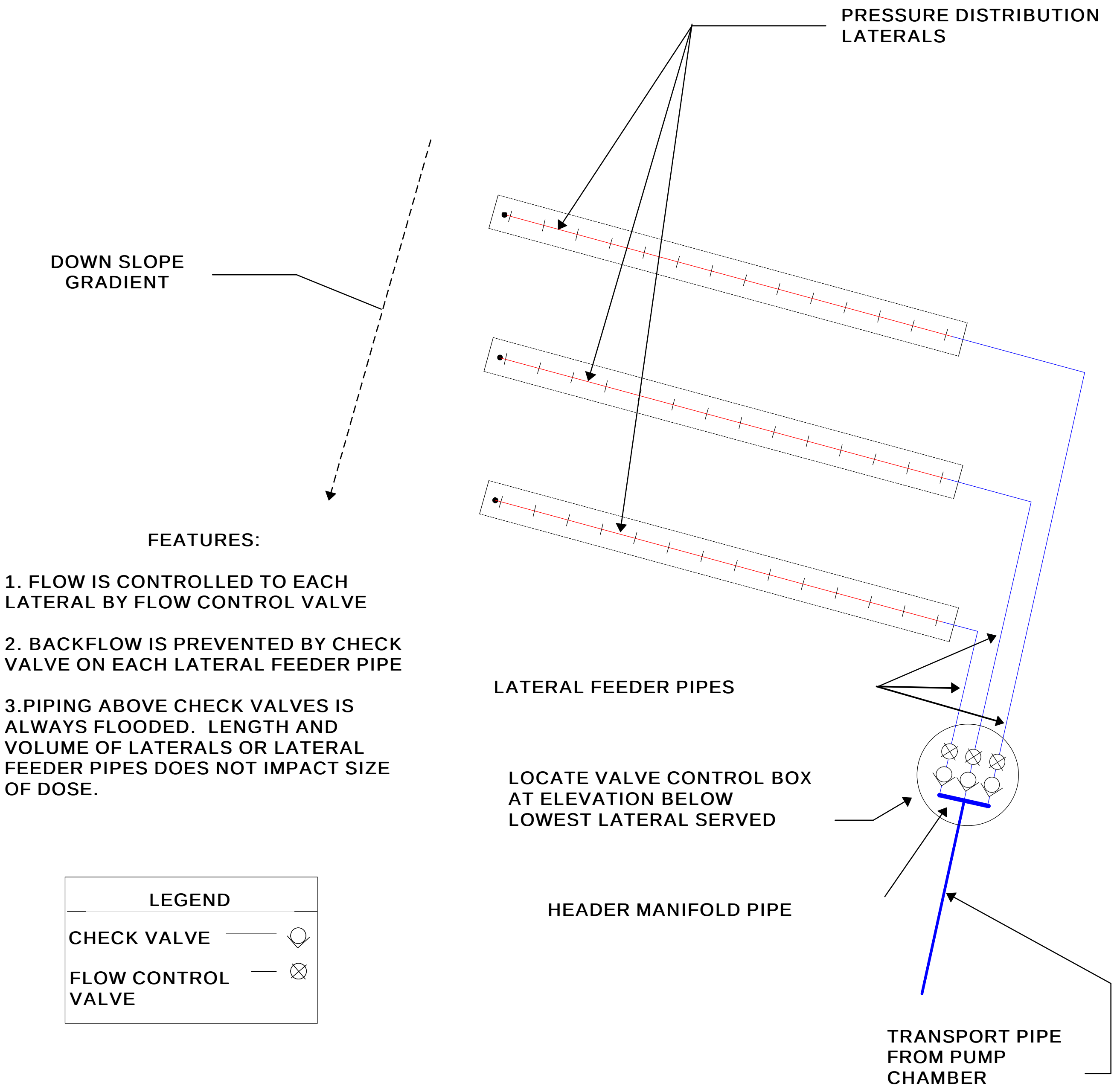
A. Manifold / Lateral Connection:

The laterals can be connected to the manifold in several ways. The manifold to lateral connection must be appropriate for the site and use conditions. Several types are described below.

1. A header manifold is positioned at an elevation below the laterals (Figure 3A), with check valves, flow control valves and feeder lines to each lateral. This configuration will maintain the manifold, feeder lines and laterals full between doses, will not allow drain back, and can be adjusted at one location to equalize residual head in all laterals. This arrangement can deliver small volumes per dose, allowing many doses per day, if desired. Caution should be taken to minimize the potential for effluent freezing in the laterals and manifold.

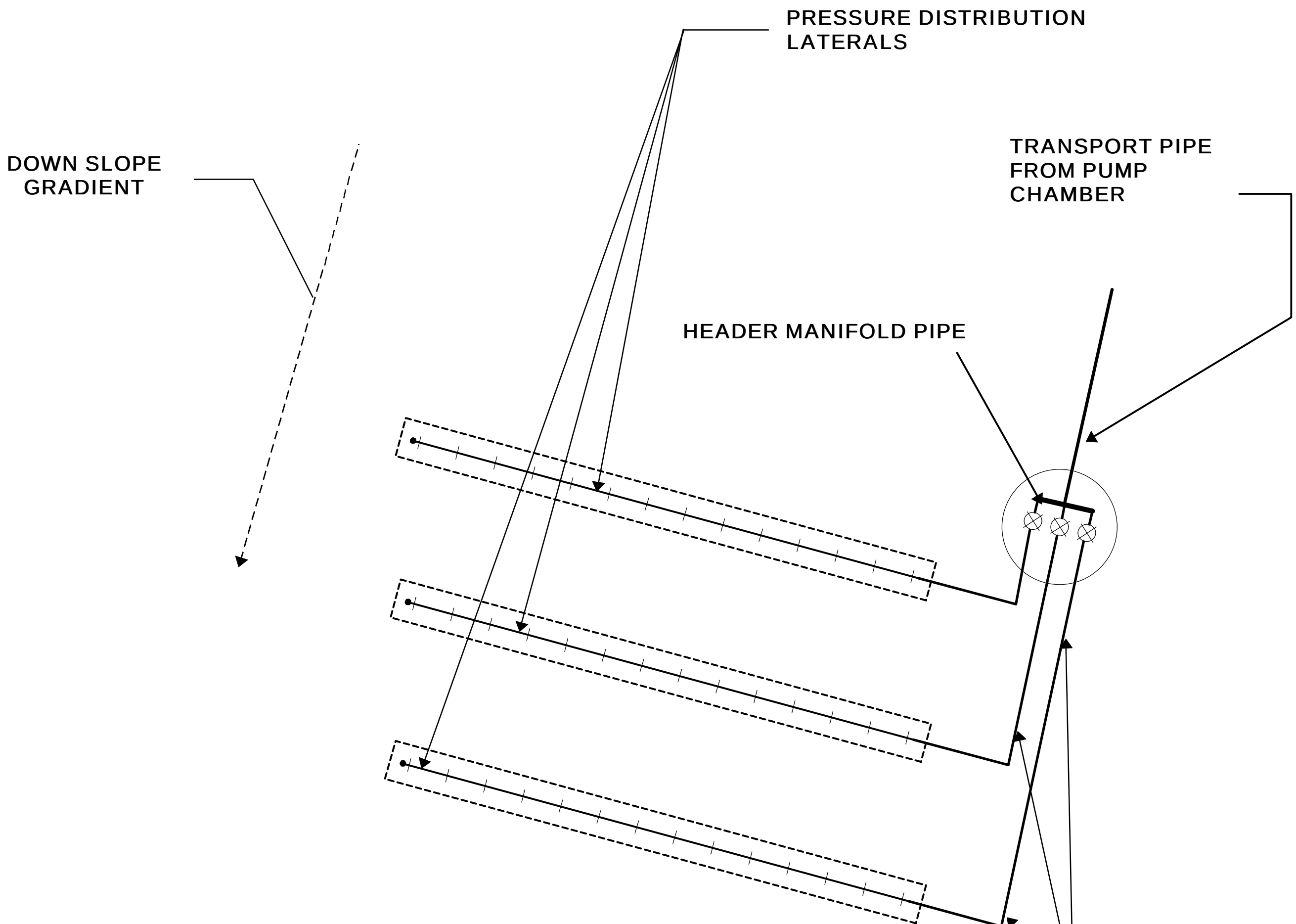
   Check valves occasionally require maintenance, and therefore should be installed so that they can be removed for servicing or replacement. This means that unions or some other fittings need to be included in the installation to allow service to the check valves while avoiding destruction or severe excavation of the manifold. Their location must be well documented and marked, or must be located in a structure that is accessible from the surface. Some brass check valves can be disassembled without removing them from the line.

2. A header manifold is placed at an elevation above the laterals (Figure 3B) without check valves, with flow control valves and feeder lines to each lateral. The measured flows from an orifice in each lateral are nearly equal without the use of check valves and without maintaining the system full between doses.



<u>PRESSURE DISTRIBUTION DRAINFIELD (SLOPING GROUND)</u>

FIGURE 3A



FEATURES:

1. FLOW IS CONTROLLED TO EACH LATERAL BY FLOW CONTROL VALVE

2. BACKFLOW IS PREVENTED BY MANIFOLD POSITION ABOVE LATERALS

3. ACCEPTABLE VARIANCE OF DOSE TO EACH LATERAL MAY BE IMPOSSIBLE DUE TO DIFFERING VOLUMES WITHIN EACH OF THE LATERAL FEEDER PIPES, ALL OF WHICH DRAIN AFTER PUMP CYCLE

LEGEND
CHECK VALVE
FLOW CONTROL VALVE

PRESSURE DISTRIBUTION DRAINFIELD (SLOPING GROUND)

FIGURE 3B

3. Tee-to-Tee with manifold below (See Figure 4) - When freezing and sloping site conditions are not a concern, this method of construction can be used to allow a very rapid pressurization of the system, especially if the transport line remains full between doses. When check valves are used in the manifold just downstream of each lateral, the manifold (and laterals too, when orifices are in the 12 o'clock position) stays full of effluent between doses. With this style, (1) there is no drainback from the upper laterals and manifold into the lower lateral, (2) the systems is completely charged within just a second or two after the pump is turned on, and (3) the system can be dosed with very small volumes per dose.

   Note caution about check valves in section A.1 of this section.

4. Cross construction (See Figure 5) - If the lateral orifices are drilled in the 6 o'clock position, this design will allow the laterals and a portion of the manifold to drain between doses, assuming the transport line remains full between doses.

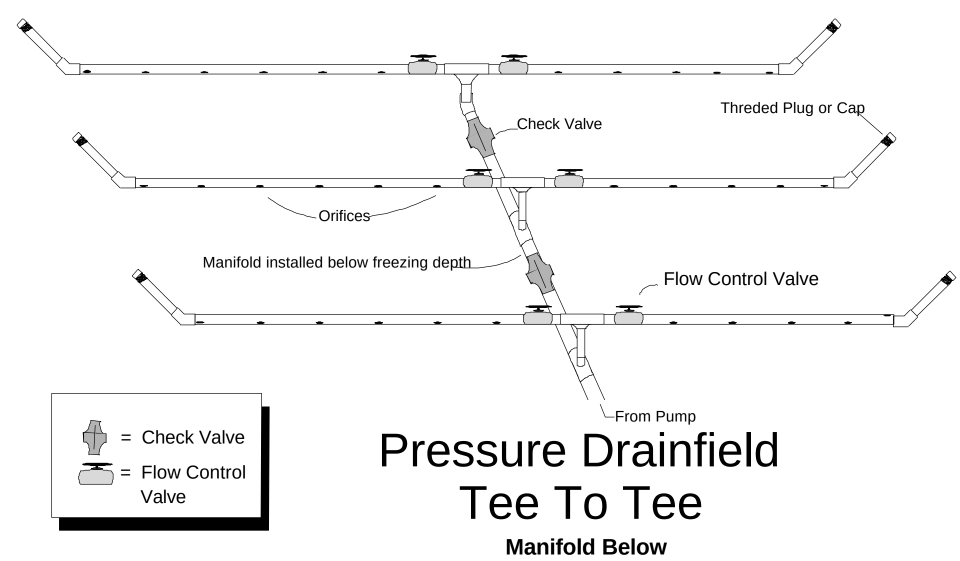


Figure 4

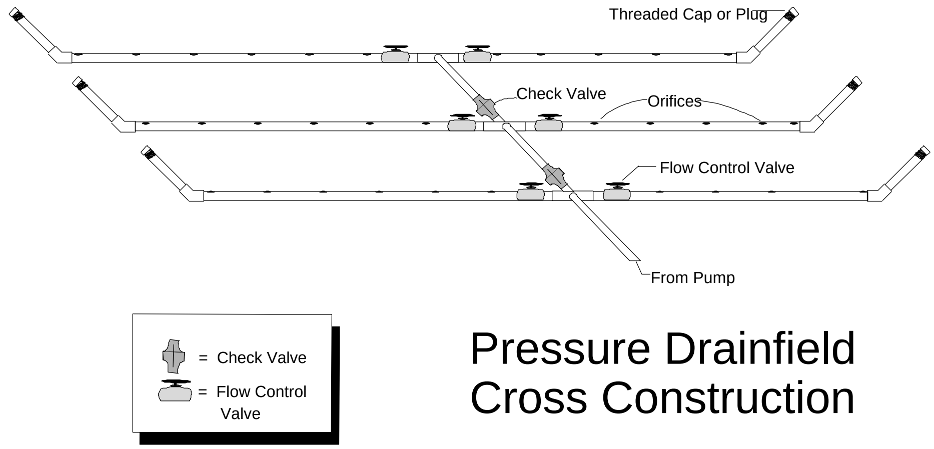
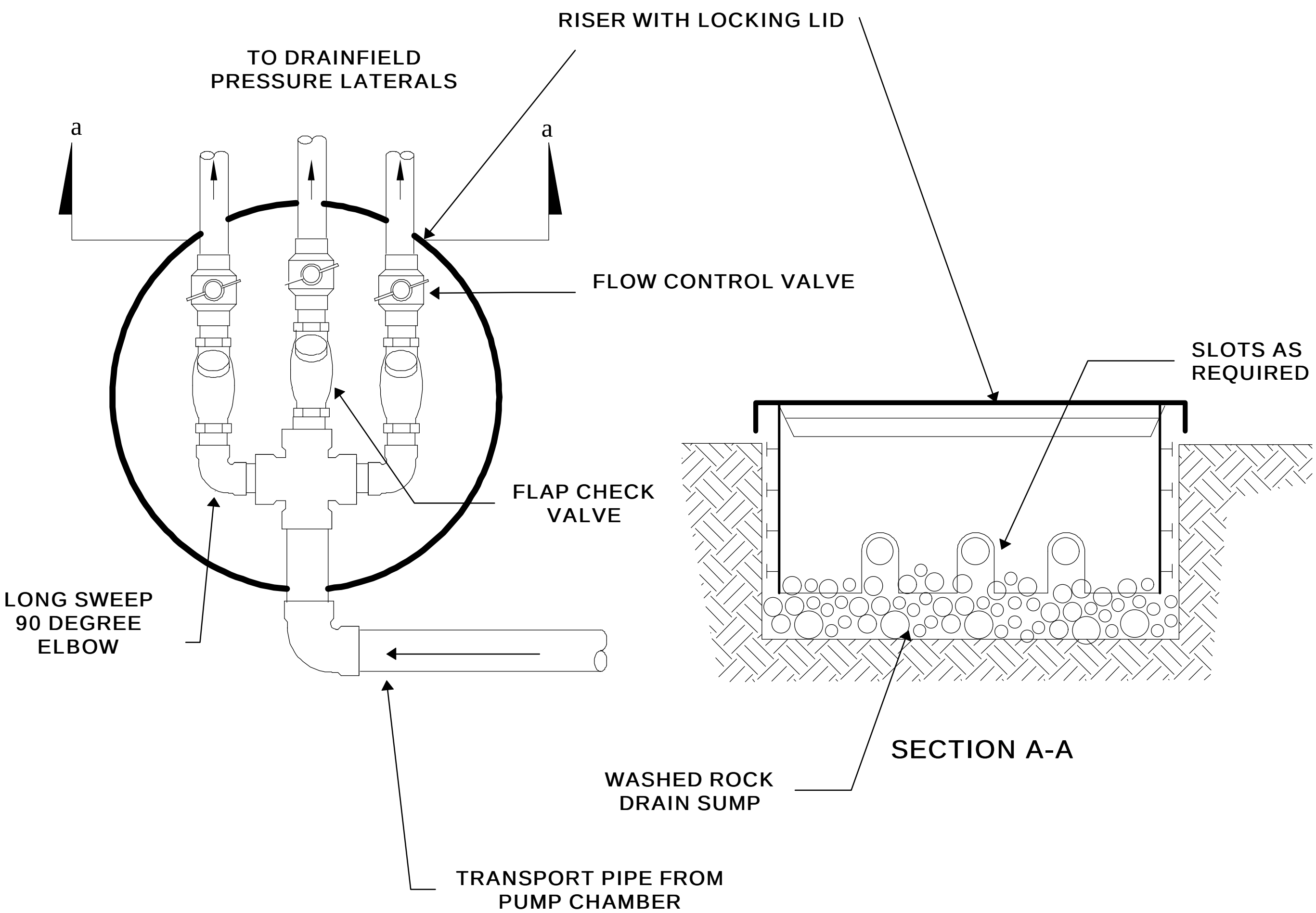


Figure 5

5. Tee-to-Tee with the manifold above - If the lateral orifices are drilled in the 6 o'clock position, the entire distribution network will drain after each dose. This may be desirable on a sloping site (where check valves are not installed in the manifold), to prevent upper laterals from draining back through the manifold to the lowermost laterals, thereby overloading them. If the orifices are drilled in the 12 o'clock position, the laterals will remain full between doses. This may be desirable when the objective is to pressurize the distribution network quickly without the use of check valves. Caution should be taken to minimize the potential for effluent freezing in the laterals.

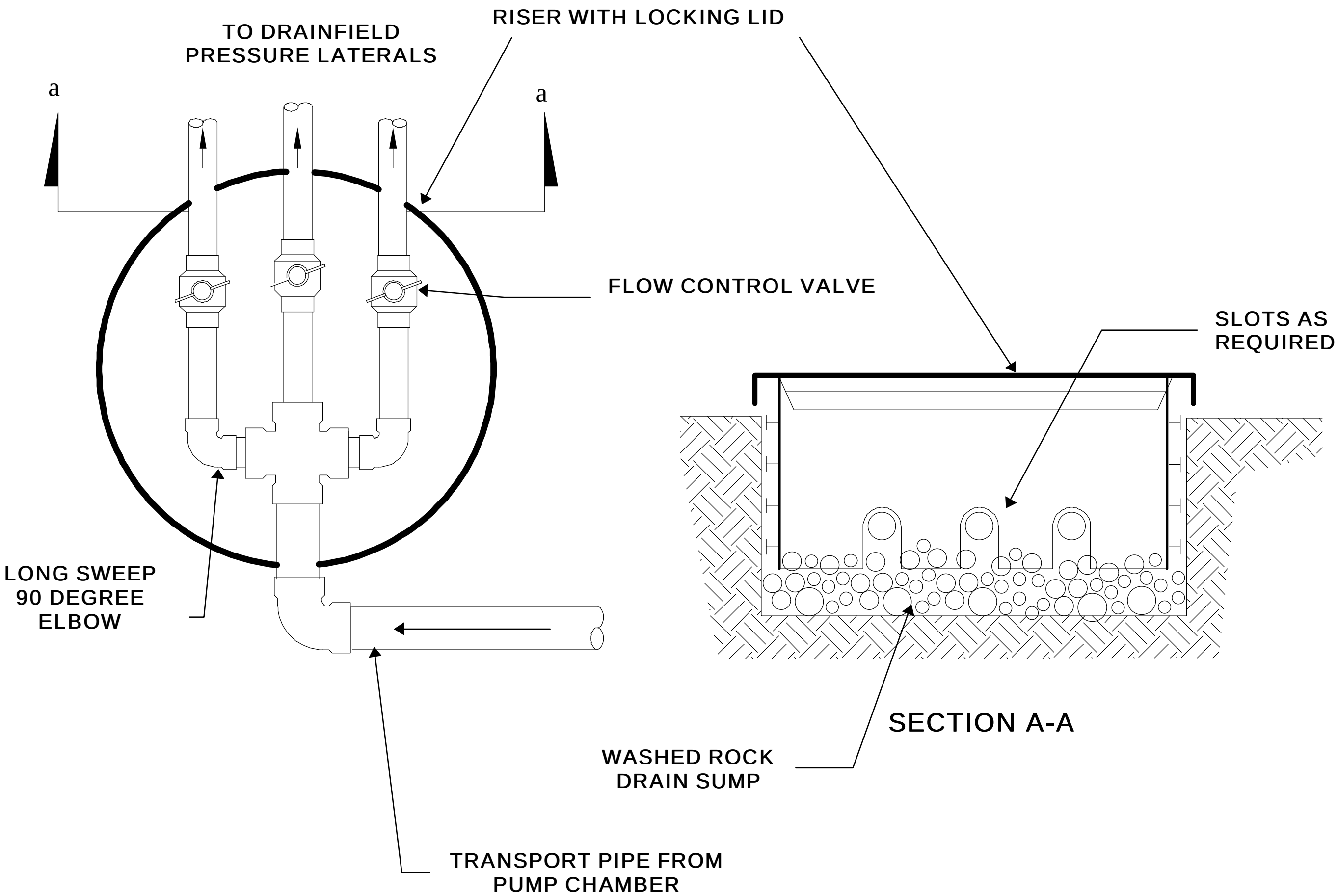
B. Sloping Sites:

Manifold designs for sloping sites are particularly critical. Laterals at different elevations will have different residual pressures, with the lowest lateral having the highest residual. In addition, if the manifold is not designed correctly the lowest lateral will receive pressure before the top lateral and system backflow will continue to the lower laterals after the pumping cycle has ended. In this instance, the lowest trench will receive more flow than the others, with the potential for overload. While there may be several solutions to these problems, Figures 3A & 3B illustrate two methods for resolving them. The check valves and flow control valves shown in Figure 6A and 6B are assumed to be an integral part of the manifold.



DRAINFIELD CONTROL BOX
(SLOPING GROUND; MANIFOLD BELOW LATERALS)

FIGURE 6A



DRAINFIELD CONTROL BOX
(SLOPING GROUND; MANIFOLD BELOW LATERALS)

FIGURE 6B

X. Laterals

The laterals in a pressure distribution system are perhaps the most important design aspect. All design considerations to this point are essentially to serve the delivery of equal flows to each square foot of drainfield bottom area.

A. Residual Pressure Requirements:

For systems with orifice diameters of 3/16 inch or larger, the minimum residual head at the orifice is 2 feet. For systems with 1/8 inch orifices, the minimum residual head is 5 feet.

B. Orifice Design:

The actual flow rate from each orifice is best represented by the equation:

$$Q_o = 11.79\ d^2\ h^{0.5}$$

where:

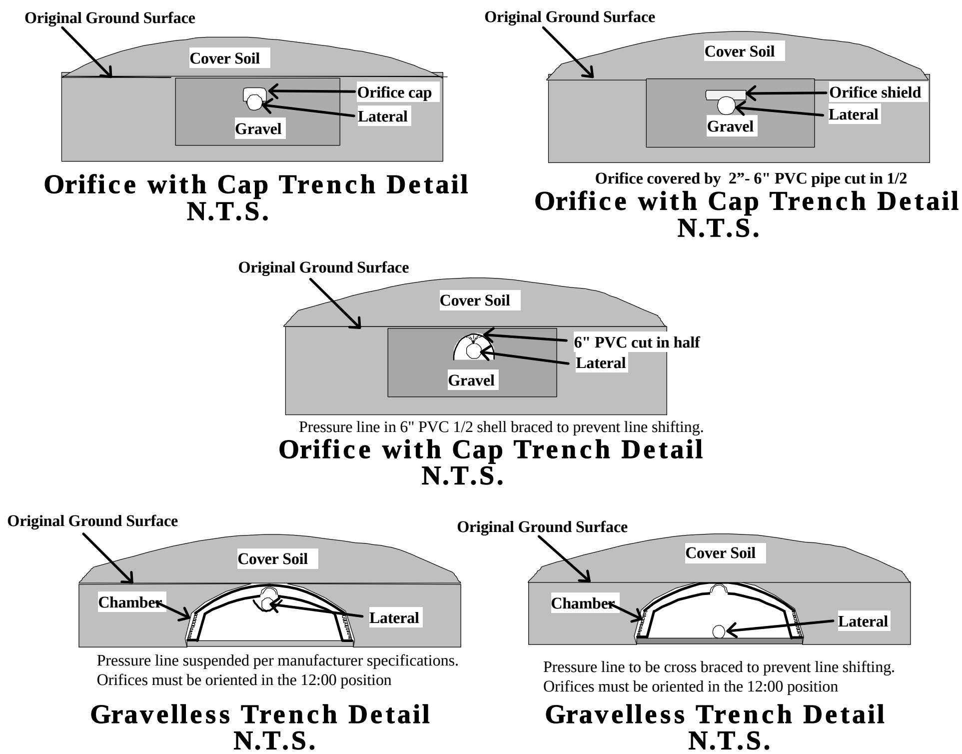
Q_o is the orifice flow in gallons per minute
d is the orifice diameter in inches
h is the discharge head in feet
(see Appendix C-2 for a derivation of this equation)

There are other factors complicating accurate calculation of the orifice flow rate such as accurate drilling of holes, class of pipe, size of pipe, and slight variations in the friction coefficients used for fittings. Proper technique and practice in drilling holes includes use of proper drill size and a sharp bit. Accurate holes also may require jigs or other drill stabilizing tools to prevent wobble and to drill the hole perpendicular to the pipe. Proper layout and control will ensure that the design number of orifices are actually placed in each lateral.

The above formula for calculating orifice discharge rates is recommended. However, the choice of coefficient to use in a design can vary from 11.79 to 16, depending on the experience of the designer in being able to predict accurately and control for the friction losses and other variables of construction and manufacture. For many designers, experience has shown that use of a slightly higher coefficient in the equation more accurately predicts the actual flow. *For whichever coefficient is selected, it is critically important that the same coefficient be used throughout the design.* Other ways to handle the inaccuracies are to add 10% to the total flow after the calculations, or to design to more than minimum residual head. All of these are acceptable.

C. Orifice Size and Orientation:

Orifice size may be as small as 1/8 inch diameter, and in systems where orifices are smaller than 3/16 inch the residual pressure must be a minimum of 2.18 psi (5 feet of head). Systems with orifices of 3/16 inch diameter or larger must have a minimum residual pressure of 0.87 psi (2 feet of head). Orifices may be oriented up or down but when oriented upward they must be covered by an orifice shield or a gravelless chamber (See Figure 7 and section on Orifice Shields). When using gravelless chambers with pressure distribtion, the **orifices must be oriented in the 12 o'Clock position**. A discussion on the advantages and disadvantages of orifice orientation is contained in Appendix A.



Orifice Caps and Shields

Figure 7

D. Orifice Spacing:

Sand filters (including sand lined trenches), mounds and pressure distribution in soil types 1B, 2A and 2B must have a minimum of one orifice per 6 ft^2 of infiltrative surface area, evenly distributed. In other soil types, there must be a minimum of one orifice every six feet on center along the lateral. The maximum spacing between the outside laterals and the edge of the bed shall be 1/2 of the selected orifice spacing, ±0.5 feet. While these are minimum orifice requirements, orifices spaced at closer intervals may be prudent.

To prevent excessive variations in discharge rates and possible subsequent localized hydraulic overload, the maximum acceptable flow deviations stated in the Performance Testing section of this document must be heeded.

E. Orifice Shields:

When orifices are oriented in the 12 o'clock position, orifice shields or gravelless chambers must be provided Shielding prevents gravel from partially blocking or restricting the orifices and therefore assures proper flow distribution. Orifice shields may be the half pipe design, the local cap type, or another design which accomplishes the same end result. The shields must be strong enough to withstand the weight of the backfill and large enough to protect the orifice from being plugged by pieces of gravel.   (See Figure 7)

F. Lateral Size:

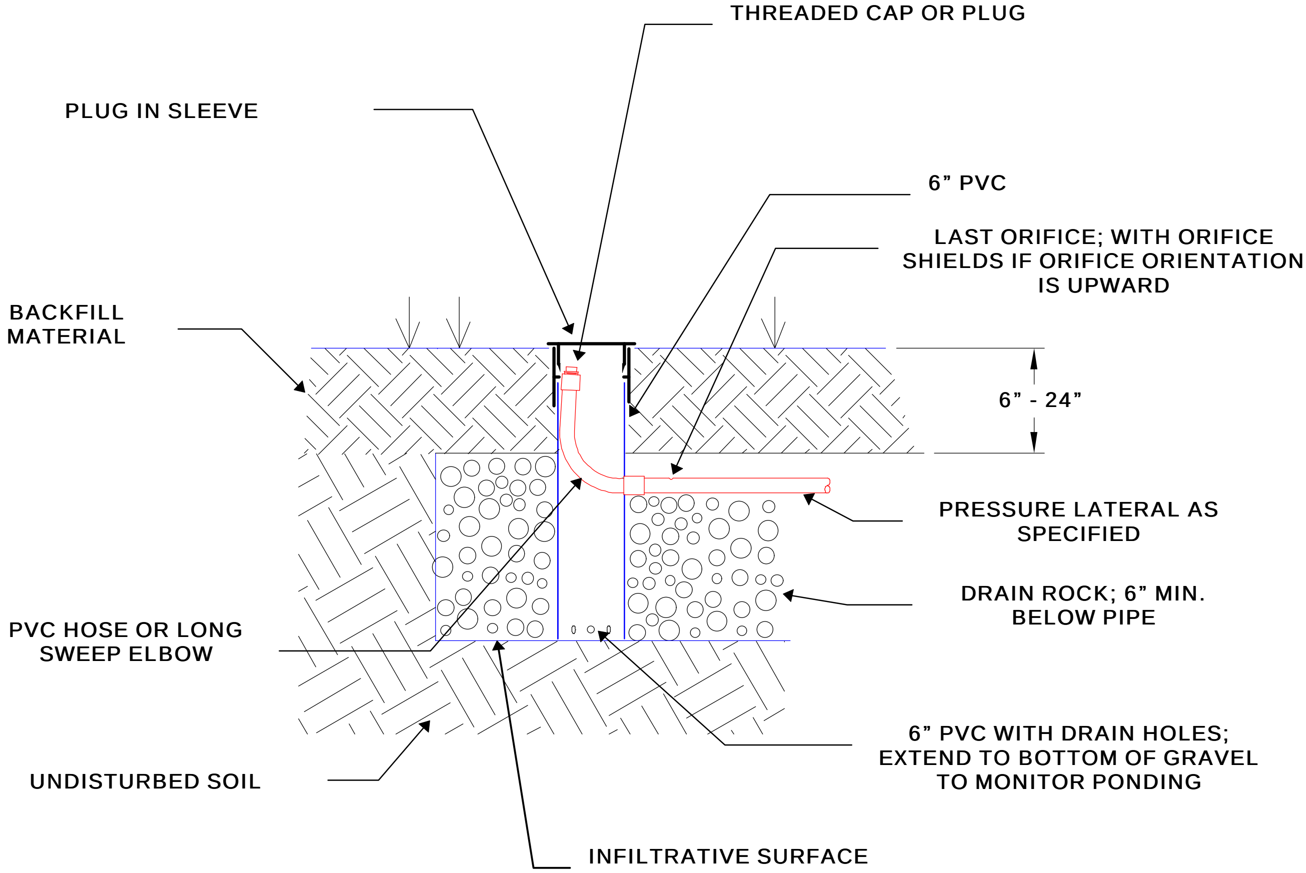
The size of the lateral diameter is determined by the flow rate through each orifice, the number of orifices, the friction losses within the pipe, the length of the lateral, and the requirement that the maximum variation in orifice flow within any single lateral cannot exceed 10 percent. The formula for determining the lateral diameter, and tables derived from the formula can be found in Appendix C.

G. Cleanouts/Monitoring Ports:

All pressure distribution laterals must be equipped with cleanouts/monitoring ports at the distal ends (see Figure 8).   These cleanouts/monitoring ports must:

- have threaded removable caps or plugs on the ends of the laterals to allow for cleaning the laterals and for monitoring the lateral pressure,
- be at least 6 inches in diameter to allow access to caps or plugs,
- be accessible from the ground surface,
- be open and slotted at the bottom, and
- be void of gravel to the infiltrative surface to allow visual monitoring of standing water in the trench or bed.

The functions of monitoring and cleanout can be separated and be accomplished in other ways. All designs shall show them in detail and explain how they accomplish the respective tasks.



<u>MONITORING/CLEANOUT PORT</u>
<u>(EXAMPLE)</u>

FIGURE 8

XI. Performance Testing

A. The most important testing criterion is to determine if effluent is uniformly distributed throughout the receiving system. One common measure of uniform distribution is a squirt test prior to covering the laterals. The difference in orifice discharge rate within any one lateral must not exceed 10% and over the whole system cannot exceed 15%. A 10% difference in discharge rate results in a 21% difference in squirt height and a 15% difference in discharge rate results in a 32% difference in squirt height.

This test is to confirm that the system has the minimum residual pressure, that there is flow from all orifices, and that the variation in flows are within tolerance. However, a successful test may be misleading. Where the laterals are at different elevations, the lower laterals will pressurize first and will receive effluent for a longer period. Likewise, after the pump shuts off, effluent may drain down into the lowest lateral from the manifold and perhaps also from the upper laterals. *[Note: pressure tests must be conducted with clean water.]*

B. Once it has been determined that the residual pressure throughout the network is uniform and complies with the minimum pressure requirements, an additional test for uniform distribution between laterals at differing elevations must be conducted. The volume of liquid from an orifice in each lateral is collected and during a complete pump cycle. The variation between the largest volume and smallest volume collected must not exceed 15%. Flexible hoses attached to the ends of the laterals through an orifice in the plug or cap and drained into containers can be used to capture and measure the flows. Balancing the flow to each lateral is accomplished by adjusting the flow control devices serving each lateral.

C. Systems with the features in Figure 3A and 3B (where the system does not drain between cycles) are not required to conduct a volume test as described above.

D. Pump chamber drawdown, pump run time, timer function and squirt height (for each lateral) data must be recorded with the as-built plans and records, which are submitted to the health officer and system owner.

1. Pump drawdown - the calculated volume of effluent pumped during a pump cycle, determined by measuring the number of inches drop of fluid level in the pump chamber, and calculating the volume based on the known dimensions of the chamber.

2. Pump run time - the elapsed time from pump on to pump off; usually measured with a stop watch.

3. Timer function - a stop watch determination of the length of time the pump is on and the interval between pump cycles.

4. Squirt height or residual head - The requirement is for a minimum residual head of 2 feet or 5 feet. The accurate method of measuring this residual head is to attach a clear pipe onto the end of the lateral and measure the static head which is the vertical distance between the lateral and the top of the liquid standing in the clear pipe. Another test of the residual pressure is to view the squirt height during a pump cycle. This test will confirm that all orifices are open, and that the residual pressures are within the specifications (see note on the relationship between residual head and flow in XI.A.). The static head will be more than the squirt height due to friction losses through the orifice, but the actual differences are difficult to predict. If the system meets the minimum residual head and variation tolerances with a squirt test, it will definitely pass a static test.

XII. Operation and Maintenance

As a minimum, the following items must be inspected at six months and then yearly, after the system is put into use. The local health department should require that the permit clearly delineates who must perform the inspections. Refer to the system as-built for initial readings and settings. The owners of pressure distribution systems must be notified that their system must be inspected and serviced on a yearly basis.

A. Evaluate drainfield area for:

1. Indications of surfacing effluent.
2. Appropriate vegetation.
3. Absence of heavy traffic.
4. Inappropriate building.
5. Impervious materials or surfaces.
6. Abnormal settling or erosion.

B. Evaluate laterals for:

1. Residual pressure at the distal ends. Confirm that it is the same as those recorded on as-built.
2. Equal flows in each lateral (hose and bucket technique).
3. Need for cleaning. Clean laterals and orifices as necessary.

C. Measure pump run time per cycle and drawdown. Compare with time recorded in as-built. Excessive run time coupled with higher residual pressure at the distal ends may indicate clogged orifices and laterals. Maintenance for this condition would be cleaning of the laterals. Incorrect run time consistent with corresponding incorrect drawdown indicates need for timer adjustment.

D. Test alarms for proper functioning (high and low liquid level).

E. Evaluate septic tank and pump chamber for:

1. Sludge and scum accumulations; pump as necessary.
2. Clogging, damage, and proper placement of outlet baffle screen. Clean each time it is inspected.
3. Signs of leaking in tanks and risers. Repair or replace if necessary.
4. Risers and lids being above grade and having lids that are secure.
5. Properly functioning of floats. Movement should not be restricted. Floats should be positioned correctly and provide positive instrumentation signals. Adjust and repair as necessary.

F. All findings and repairs are to be recorded, records filed for ready access, and reports sent to local health department when indicated.

XIII. Glossary

Approved: acceptable by the health officer or department as stated in writing.

Appurtenant Device: a component of a total or unit process (diffuser, chemical feed pump, chlorinator, etc.).

Biomat: the layer of active and inactive microbes and their extracellular products that accumulates upon the infiltrative surface at the bottom of effluent distribution trenches. The "clogging" action limits the hydraulic loading rate at which dffluent can pass to the soil below.

Disposal Component: any approved method of disposal of treated or partially treated sewage.

Excessively Permeable Soils: Type 1A and 1B soils.

Intermittent Sand Filter *(an alternative system)*: a sand filter in which pretreated wastewater is applied periodically providing intermittent periods of wastewater application, followed by periods of drying and oxygenation of the filter bed.

Locking lid: a lid that is child and tamper safe. Lid must be held down with bolts or other equivalent positive locking device.

Mound System: a method of on-site sewage treatment and disposal in which a specified sand filter media is laid on top of a properly prepared original soil surface. The distribution system and wastewater infiltration beds are then placed entirely within the filter media at such a level that the desired vertical separation to provide the necessary treatment exists. The original soil provides some additional treatment and is necessary to move the effluent away from the site without surfacing. Not included in this definition are systems where soil fill is used only for cover.

Pressure Head: pressure head is the vertical height, in feet, to which any given pressure will force water.

Riser - septic tank and pump chamber: a vertical passageway from the top of the tank to the ground surface. This component shall be constructed of durable material capable of resisting attack from a sewage atmosphere and from moist or wet soil. It shall have sufficient mechanical strength to withstand the anticipated site specific load, shall be water tight, and shall have a durable mechanical connection to the tank it serves.

Sand Filter *(an alternative system)*: a biological and physical wastewater treatment unit consisting (generally) of an underdrained bed of sand to which pretreated effluent is periodically applied. Filtrate collected by the underdrains is then disposed of by an approved soil absorption system. Pretreatment can be provided by either a septic tank or another approved treatment device.

Septic Tank: a watertight treatment receptacle which receives the wastewater from a building sewer or sewers, and is designed and constructed so as to permit separation of settleable and floating solids from the liquid, detention and facultative digestion of the organic matter, prior to discharge of the liquid portion.

Soil Type 1A: soil type 1A classification of earth particles and coarse fragments that are described in the On-site Sewage System Regulation chapter 246-272-11001(2)(e) of the Washington Administrative Code as; Very gravelly coarse sands or coarser, and all extremely gravelly soils. "Very gravelly" is soil that contains >35% and <60% gravel and coarse fragments by volume. "Extremely gravelly" is soil that contains >60% gravel and coarse fragments by volume.

Treatment Component: any approved method of, or device for, treatment of sewage, or part thereof, which may include collection, storage, and transference devices, such as pipe, pumps, pump chambers, drop boxes, etc.).

Uniform Distribution: A method of distribution which results in equal distribution of the effluent throughout the distribution network. This will help assure a vertical unsaturated flow regime.

Wastewater Design Flow: the maximum volume of wastewater predicted to be generated by occupants of a structure. For residential dwellings, this volume is calculated by multiplying the number of bedrooms by 120 GPD (gallons per day).

XIV. Design Considerations Check List

This checklist is provided as a guide, to aid the designer and/or the regulator in the development, and the review, of an onsite sewage system plan incorporating a sand filter.

A. Site

1. Facility Served
   a. Type
      (1) [] residential
      (2) [] commercial:____
      (3) [] other:____
   b. Size
      (1) [] bedrooms:____
      (2) [] occupants:____
      (3) [] other:____
   c. Facility
      (1) [] new
      (2) [] existing (no changes)
      (3) [] expanding

2. Soils
   a. Texture:____
   b. Type:____
   c. Soil logs: [] attached
   d. Groundwater table level?____
      How and when determined? ______________________________
      ____
   e. Restrictive layer(s):
      [] depth:____
      [] type:____

3. Lot Size
   a. Overall:____
   b. Available Space:____
   c. Replacement area:
      [] yes: [] designated
      [] no
   d. Restrictive conditions:____
      ____
      ____

4. System
   a. [] new
   b. [] repair
   c. [] replacement
   d. [] alteration
   e. [] expansion

5. Wastewater Characteristics

a. Quality:

(1) [] household levels

(2) [] commercial [] expected [] tested

BOD_5:____

TSS:____

Fecal coliform:____________________________________

b. Quantity:

GPD:____

[] estimated

[] metered

[] peak flow

[] average flow____________________________________

B. Pre-treatment unit (Also required on design submittals)

1. Septic Tank

a. Size:____

b. Special Considerations:_______________________________________

____

2. Aerobic Tank

a. Type: [] flow through [] batch

b. Manufacturer:____

c. Supplier:____

d. Size:____

e. Approved? [] State [] Local

(Approval documentation provided?)

3. Other in-line devices

a. Grease trap

(1) Type: ____

(2) Size: ____

(3) Special considerations:_____________________________________

____

____

b. Wastewater-strength reducer/modifier

(1) Type: ____

(2) Manufacturer: ____

(3) Supplier: ____

(4) Size: ____

(5) Status?

[] Alternative Unit

[] Experimental Unit

(6) Approved?

[] state

[] local

4. Siting conditions/requirements for items 1,2,3 above:
____
____
____

5. Access for Service:____
____

C. Specific Pressure Distribution Components

1. Effluent baffle screens / filters
   a. Type
   b. Meets criteria of guideline
      [ ] yes [ ] no
   c. Manufacturer: ____
   d. Supplier: ____
   e. Access for service: ___________________________________
   ____
   ____

2. Pump Chamber
   a. Size: ____
   b. Gallons per dosing cycle: _______________________________
   c. Access to ground surface? [ ] yes [ ] no
   d. Adequate storage volume beyond dosing volume?
      [ ] yes [ ] no
   e. Elevations: pump "on" ______________________________
      pump "off" ______________________________

3. Pump(a)
   a. Type / Model: ____
   b. Manufacturer:____
   c. Supplier: ____
   d Size: ____
   e. Approved: ____

4. Controls
   a. Panel
      (1) Type / Model: ____
      (2) Manufacturer: ____
      (3) Supplier: ____
      (4) Weatherproof (if necessary): [ ] yes [ ] no
      (5) Approved: ____
   b. Components
      (1) Run cycle meter
      (2) Cycle counter
      (3) Pump controls
         (a) Pump run time controller
         (b) Timed pump cycle control

b. Components (continued)

(4) Alarm - visual and audible [ ] yes [ ] no
Location: ____

c. Floats
(1) Type / model: ____
(2) Manufacturer: ____
(3) Settings (elevation in pump chamber for on, off and alarm)
____
____

5. Distribution System
a. Type
[ ] Trenches [ ] Sand filter or sand-lined treanches / bed
[ ] Bed [ ] Mound
[ ] Other: ____
____

b. Placement
[ ] Initial
[ ] Replacement

6. Transport Line
a. Length: ____
b. Pipe classification: ____
\ c. Pipe size: ____
d. Volume that drains between pump cycles: ____________________________

7. Manifold
a. Size: ____
b. Length: ____
c. Style: [ ] Manifold above laterals
[ ] Manifold below the laterals
[ ] Other arrangement (describe or sketch)
d. Valves (flow control) at head of each lateral)
(1) Size: ____
(2) Type: ____
(3 Locations: ____
e. Check Valves
(1) Type: ____
(2) Location: ____
(3) Other: ____

8. Laterals and Orifices
a. Pipe diameter: ____
b. Type of pipe: ____
c. Length of laterals: ____
d. Orifice size: ____
e. Orifice spacing: ____
f. Orifice orientation: ____

8. Laterals and Orifices (continued)

g. Cleanouts / inspection ports:
[ ] at end of each lateral
[ ] meets guideline specifications

D. Full System Concerns

1. Agreements / documents
(easements, protective covenants, user's manuals, service / maintenance contracts, etc.)

2. Monitoring requirements, agreements, contracts

3. Waivers
[ ] Needed?
[ ] Applied for?
[ ] Granted?
[ ] Denied?

4. Compliance with DOH / TRC Alternative Guidelines?

5. Experimental components, DOH / TRC approval?

E. Notes / Comments:

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APPENDIX A

Advantages / Disadvantages of: Demand Dosing, Timed Dosing, Reduced Dose Volumes, Orifices in 12:00 o'clock Position, Orifices in 6 o'clock Position, Network Remaining Full or Partially Full between doses.

1. Demand Dosing

    a. Least complex of control systems and therefore least costly to install and easiest to understand.
    b. Not sensitive to heavy use days and therefore will not activate the alarm circuit with weekend guests, large laundry days or parties.
    c. Does not protect the drainfield, mound or sandfilter from hydraulic surges and overload.
    d. Does not meter the effluent to the receiving component throughout a 24 hour period; instead delivers the dose whenever a dose volume accumulates in the pump chamber. Household water use patterns are usually in morning, evening and weekend surges.

2. Timed Dosing

    a. Meters the effluent to the receiving component in discrete, evenly spaced doses.
    b. Allows more frequent, smaller doses to be pumped to the receiving component, thereby assuring unsaturated flow through the soil or filter media.
    c. Protects the receiving component from hydraulic overload.
    d. Sensitive to heavy use days and therefore may often activate the alarm circuit when the volume of wastewater exceeds the design flow. Some causes are: weekend guests, large laundry days or parties.
    e. More costly and complicated installation and maintenance.
    f. Can be used to help detect groundwater leaking into the septic tank or pump chamber.

3. Reduced Dose Volumes

    a. More frequent, smaller doses with intervening resting and aeration periods, are pumped to the receiving component, thereby assuring unsaturated flow through the soil or filter media.
    b. May require smaller orifices, smaller transport and lateral pipes, check valves and orifices in the 12 o'clock position in order to reduce the flow rate and to maintain the system full of effluent between doses. The smaller orifices will increase the frequency of maintenance due to clogging. Likewise, maintaining the pipes full of effluent between doses will promote biological

growth to occur more rapidly on the inside of the pipes and thereby promote clogging of the orifices.

4. Orifices in the 12 o'clock Position

   a. As mentioned above, orifices in this position will maintain the laterals full or partially full and therefore reduce the amount of effluent needed to pressurize the system. This feature is important when designing a system with reduced dose volumes.
   b. Orifices in the "up" position require the use of orifice shields or chambers, to prevent blocking of some orifices with gravel pieces. Shields also deflect the squirt over a wider surface area and spread the effluent over more of the infiltrative surface. Shields have the greatest importance in systems with medium to coarse sand soils or with imported media providing the treatment.
   c. Maintaining effluent in the lines will promote biological growth which will accelerate clogging of the orifices and buildup of sludge and slime in the lines. It also makes the laterals subject to freezing in areas where this is a concern.
   d. May be drained by putting a few orifices in the 6:00 o'clock position, but will increase dose volume.

5. Orifices in the 6 o'clock Position

   a. When some or all of the orifices are in the "down" position, the laterals will drain between dose cycles retarding the biological growth in them and reducing freeze up potential.
   b. When the orifice at the distal end (farthest from the manifold) is in the down position, sludge in the lines tends to be driven to the distal end of the lateral and out the last orifice.
   c. Although systems with some or all of the orifices in the down position will be self-cleaning, they also will require a larger dose volume to pressurize the system, due to laterals draining between pump cycles.
   d. Orifices in the down position cannot be directed to gravelless chambers, and therefore will not have as wide a distribution pattern. However there are special orifice shields available for orifices oriented in this position.

6. Network Remaining Full, or Partially Full, Between Doses (laterals can rarely be maintained at a level grade, therefore some orifices will be lower than others, so some of the effluent will drain out the lowest 12:00 o'clock orifice)

   a. Allows smaller, more frequent doses with intervening resting and aeration periods, to be pumped to the receiving component, thereby assuring unsaturated flow through the soil or filter media.

   b. Maintaining effluent in the lines will promote biological growth which will accelerate clogging of the orifices and buildup of sludge in the lines. It also makes the laterals subject to freezing in areas where this is a concern.

APPENDIX B

SIPHON SYSTEMS

Requirements for siphon systems:

1. Area to be dosed must be downhill from the siphon chamber.

2. Effluent must be screened before entering the siphon chamber.

3. Must be installed to allow access for maintenance and cleaning.

4. Dose counter(s) must be incorporated into the design and installation.

5. Can only be used where timed dosing is not required, or where a small electric pump is used to deliver effluent to the siphon chamber. In this latter case the electric pump is controlled to deliver no more than the daily design flow to a sandfilter, mound or sand-lined drainfield that is then dosed by a siphon.

6. May only be used where they will be monitored and managed to the satisfaction of the local health officer.

Other important considerations:

1. Proper siphon size must be selected, as they are available in many sizes.

2. Air leaks in the siphon or fittings will prevent the siphon from functioning.

3. If the siphon chamber fills too rapidly, the bell and siphon will not receive a full dose of air and will enter a trickling mode.

4. Adjustment to the "trip" level of the liquid in the siphon chamber is limited; dose volume is better handled by careful sizing of the siphon chamber.

5. Blockage of the snifter tube, even momentarily, at the end of the discharge cycle, will cause the siphon to enter a trickling mode.

6. Transport pipe must be vented just outside the siphon chamber and other venting must be placed in the system as needed.

7. It is advisable not to bury the transport pipe until the system is tested and proper operation is verified; additional venting may be needed for unanticipated air locks (see Figures 9 and 10).

Advantages / Disadvantages of Siphon Dosed Systems

1. Some advantages of siphons are:

   a. they do not require electricity;

   b. there are no moving parts;

   c. they can be constructed entirely of corrosion resistant material;

   d. they require very little maintenance;

   e. they do not require external controls as cycling is automatic;

   f. duplex installations can be made to alternate automatically;

   g. they can dose a remote drainfield without a large transport line to the siphon chamber;

   h. they allow the use of small pumps with low energy consumption, to dose a system with high velocity requirements; and

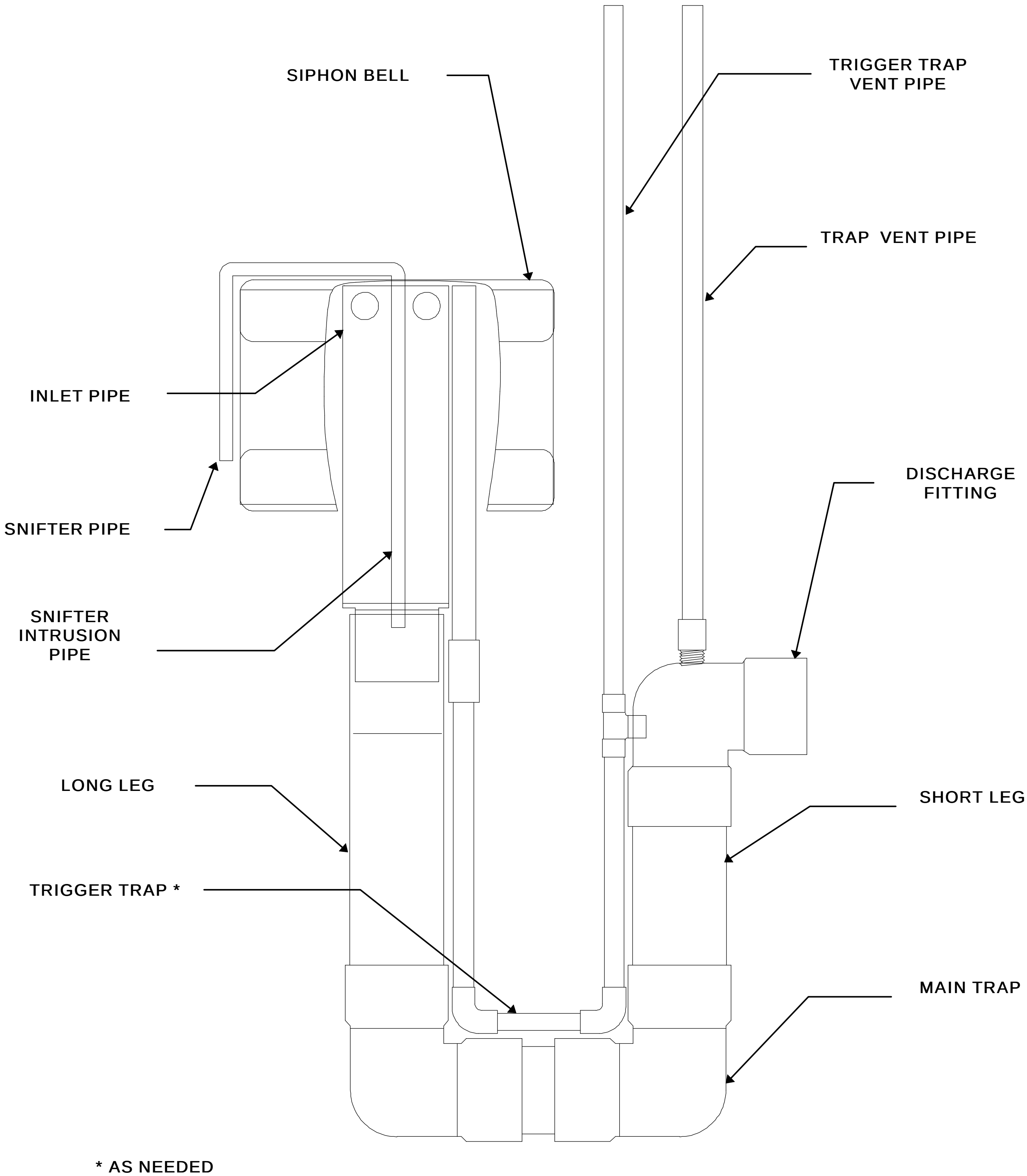
2. Some drawbacks of siphons are:

   a. they cannot, by themselves, limit the total volume discharged to the drainfield in a day and therefore cannot protect the pressure distribution component from hydraulic overload;

   b. they can go into a trickling mode and will remain there until manually recharged with air;

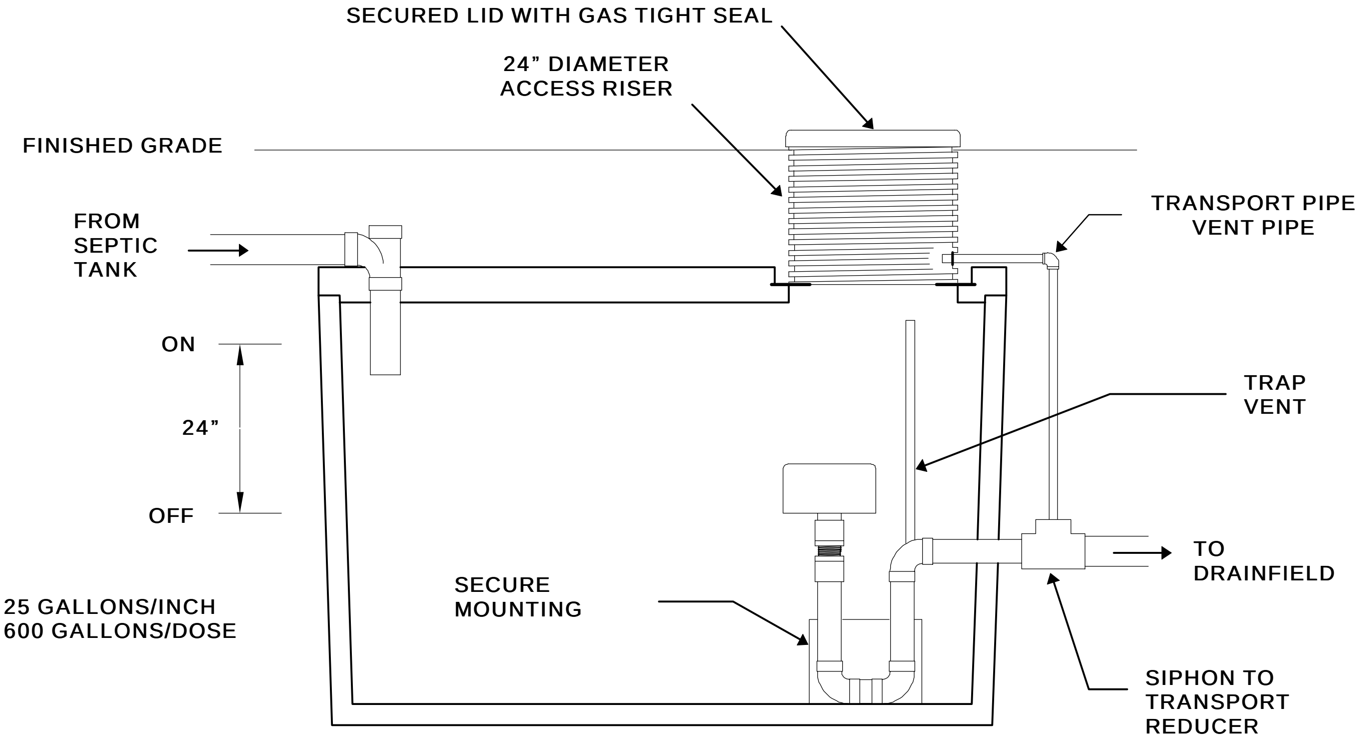
   c. they are slower to enter the fully pressurized phase which can result in somewhat unequal distribution on a sloped site; and

   d. the available head to pressurize the system is fixed and therefore design and installation errors cannot be overcome by increasing the pressure head.

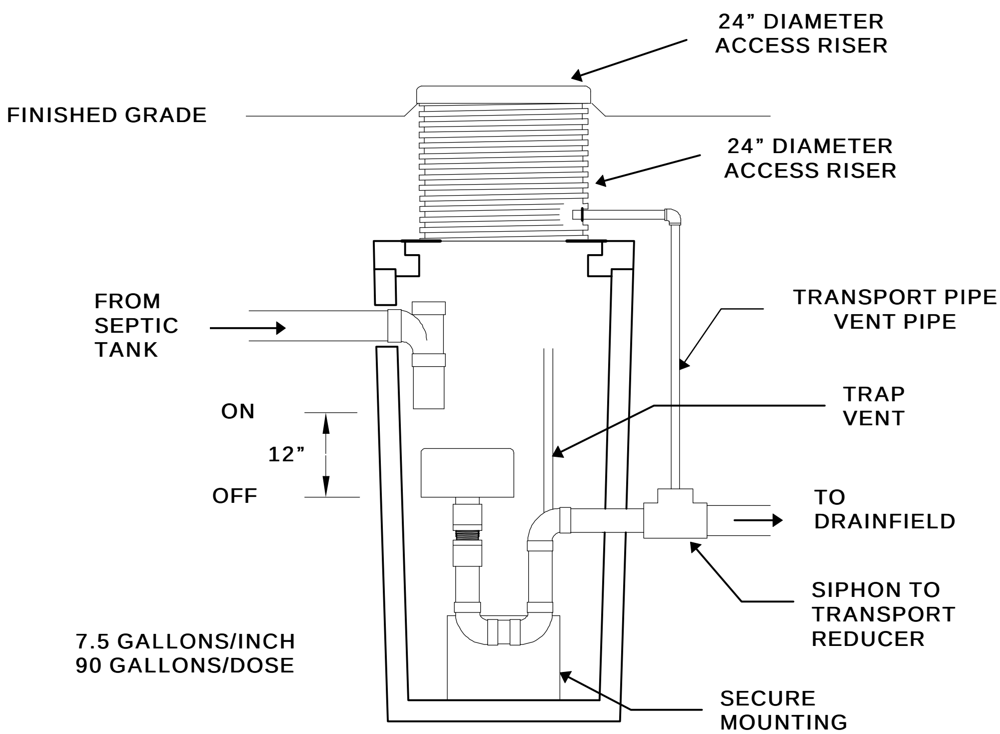


SIPHON NOMENCLATURE
(TYPICAL)

FIGURE 9



SIPHON TANK
HIGH DOSE VOLUME EXAMPLE



SIPHON TANK
LOW DOSE VOLUME EXAMPLE

FIGURE 10

APPENDIX C

USEFUL TABLES FOR PRESSURE DISTRIBUTION

The design tables in the four sections of this appendix have been developed in order to allow the designer to evaluate alternative lateral configurations.

Appendix C-1, LATERAL DESIGN TABLE, has a table of maximum lateral lengths for various lateral diameters, orifice diameters and orifice spacings, and includes design criteria used to calculate maximum lateral lengths.

Appendix C-2, ORIFICE DISCHARGE RATE DESIGN AID, contains a derivation of an equation used to calculate orifice discharge rates and includes a table of discharge rates for various residual heads and orifice diameters.

Appendix C-3, FRICTION LOSS DESIGN AID, includes a derivation of an equation that can be used to calculate friction losses and a table of constants to simplify the calculation. Also included is a table of friction loss for PVC pipe fittings.

Appendix C-4, MAXIMUM MANIFOLD LENGTHS, lists the assumptions used to calculate the enclosed tables for maximum manifold length, one for 1/8 inch and 5/32 inch orifices (where the minimum residual head at the distal orifice must be 5 feet) and one for orifices of 3/16 inch and up (where the minimum residual head at the distal orifice must be 2 feet).

Throughout Appendix C, it is assumed that laterals and manifolds will be constructed using only PVC pipe materials conforming to ASTM standards D-2241 or D-1785.

APPENDIX C-1

LATERAL DESIGN TABLES

The maximum allowable length for any lateral is determined by allowable differences in discharge rates between the proximal and distal orifices. These tables assume that $Q_p/Q_d \leq 1.1$;

Where Q_p = the proximal orifice discharge rate
Q_d = the distal orifice discharge rate

The maximum allowable difference in discharge rates is 10% . The maximum allowable lateral length is a function of lateral diameter and orifice diameter and is independent of the residual pressure.

Orifice discharge rates are a function of orifice diameter and residual pressure (see APPENDIX C-2 for a discussion).

TABLE C-1

Lateral Design Table

			Maximum Lateral Length (ft)	
Orifice Diameter	Lateral Diameter	Orifice Spacing	Pipe Material*	
(inches)	(inches)	(inches)	Schedule 40	Class 200
1/8	1	1.5	42	51
1/8	1	2	50	62
1/8	1	2.5	57.5	72.5
1/8	1	3	66	81
1/8	1	4	80	96
1/8	1	5	90	110
1/8	1	6	102	126
1/8	1.25	1.5	66	76.5
1/8	1.25	2	80	92
1/8	1.25	2.5	92.5	107.5
1/8	1.25	3	105	120
1/8	1.25	4	124	144
1/8	1.25	5	145	165
1/8	1.25	6	162	186

* Note: Class 160 pipe is allowed only for pipe sizes greater than 2 inches diameter.

Lateral Design Table (cont.)

			Maximum Lateral Length (ft)	
Orifice Diameter (inches)	Lateral Diameter (inches)	Orifice Spacing (inches)	Pipe Material Schedule 40	Class 200
1/8	1.5	1.5	85.5	96
1/8	1.5	2	104	116
1/8	1.5	2.5	120	135
1/8	1.5	3	135	150
1/8	1.5	4	164	184
1/8	1.5	5	190	210
1/8	1.5	6	210	240
1/8	2	1.5	132	141
1/8	2	2	160	170
1/8	2	2.5	185	197.5
1/8	2	3	207	222
1/8	2	4	248	268
1/8	2	5	290	310
1/8	2	6	324	348
5/32	1	1.5	31.5	39
5/32	1	2	36	46
5/32	1	2.5	42.5	52.5
5/32	1	3	48	60
5/32	1	4	56	72
5/32	1	5	65	80
5/32	1	6	72	90
5/32	1.25	1.5	48	55.5
5/32	1.25	2	58	68
5/32	1.25	2.5	67.5	77.5
5/32	1.25	3	75	87
5/32	1.25	4	92	104
5/32	1.25	5	105	120
5/32	1.25	6	120	138

Lateral Design Table (cont.)

			Maximum Lateral Length (ft)	
Orifice Diameter (inches)	Lateral Diameter (inches)	Orifice Spacing (inches)	Pipe Material	
			Schedule 40	Class 200
5/32	1.5	1.5	63	70.5
5/32	1.5	2	76	84
5/32	1.5	2.5	87.5	97.5
5/32	1.5	3	99	111
5/32	1.5	4	120	132
5/32	1.5	5	140	155
5/32	1.5	6	156	174
5/32	2	1.5	96	103.5
5/32	2	2	116	124
5/32	2	2.5	135	142.5
5/32	2	3	150	162
5/32	2	4	184	196
5/32	2	5	210	225
5/32	2	6	240	252
3/16	1	1.5	24	30
3/16	1	2	28	36
3/16	1	2.5	32.5	42.5
3/16	1	3	39	45
3/16	1	4	44	56
3/16	1	5	50	65
3/16	1	6	60	72
3/16	1.25	1.5	37.5	43.5
3/16	1.25	2	46	54
3/16	1.25	2.5	52.5	62.5
3/16	1.25	3	60	69
3/16	1.25	4	72	84
3/16	1.25	5	85	95
3/16	1.25	6	96	108

Lateral Design Table (cont.)

			Maximum Lateral Length (ft)	
Orifice Diameter (inches)	Lateral Diameter (inches)	Orifice Spacing (inches)	Pipe Material	
			Schedule 40	Class 200
3/16	1.5	1.5	49.5	55.5
3/16	1.5	2	60	68
3/16	1.5	2.5	70	77.5
3/16	1.5	3	78	87
3/16	1.5	4	92	104
3/16	1.5	5	110	120
3/16	1.5	6	120	138
3/16	2	1.5	76.5	81
3/16	2	2	92	98
3/16	2	2.5	105	112.5
3/16	2	3	120	129
3/16	2	4	144	152
3/16	2	5	165	180
3/16	2	6	186	198
7/32	1	1.5	19.5	24
7/32	1	2	24	30
7/32	1	2.5	27.5	35
7/32	1	3	30	39
7/32	1	4	36	44
7/32	1	5	45	55
7/32	1	6	48	60
7/32	1.25	1.5	31.5	36
7/32	1.25	2	38	44
7/32	1.25	2.5	42.5	50
7/32	1.25	3	48	57
7/32	1.25	4	60	68
7/32	1.25	5	70	80
7/32	1.25	6	78	90

Lateral Design Table (cont.)

			Maximum Lateral Length (ft)	
Orifice Diameter	Lateral Diameter	Orifice Spacing	Pipe Material	
(inches)	(inches)	(inches)	Schedule 40	Class 200
7/32	1.5	1.5	40.5	45
7/32	1.5	2	50	54
7/32	1.5	2.5	57.5	62.5
7/32	1.5	3	63	72
7/32	1.5	4	76	88
7/32	1.5	5	90	100
7/32	1.5	6	102	114
7/32	2	1.5	63	66
7/32	2	2	76	80
7/32	2	2.5	87.5	92.5
7/32	2	3	99	105
7/32	2	4	116	124
7/32	2	5	135	145
7/32	2	6	156	162
1/4	1	1.5	16.5	21
1/4	1	2	20	24
1/4	1	2.5	22.5	27.5
1/4	1	3	27	33
1/4	1	4	32	40
1/4	1	5	35	45
1/4	1	6	42	48
1/4	1.25	1.5	27	30
1/4	1.25	2	32	36
1/4	1.25	2.5	37.5	42.5
1/4	1.25	3	42	48
1/4	1.25	4	48	56
1/4	1.25	5	55	65
1/4	1.25	6	66	72

Lateral Design Table (cont.)

			Maximum Lateral Length (ft)	
Orifice Diameter (inches)	Lateral Diameter (inches)	Orifice Spacing (inches)	Pipe Material	
			Schedule 40	Class 200
1/4	1.5	1.5	34.5	39
1/4	1.5	2	42	46
1/4	1.5	2.5	47.5	52.5
1/4	1.5	3	54	60
1/4	1.5	4	64	72
1/4	1.5	5	75	85
1/4	1.5	6	84	96
1/4	2	1.5	52.5	55.5
1/4	2	2	64	68
1/4	2	2.5	72.5	77.5
1/4	2	3	81	87
1/4	2	4	100	104
1/4	2	5	115	120
1/4	2	6	126	138

APPENDIX C-2

ORIFICE DISCHARGE RATE DESIGN AID

Orifice discharge rates can be calculated using Toricelli's equation:

$$Q = C_d \, A_o \sqrt{2gh}$$

Where:
- Q = the discharge rate in ft^3/sec
- C_d = the discharge coefficient (unitless)
- A_o = the cross sectional area of the orifice in ft^2
- g = the acceleration due to gravity (32.2 ft/sec^2)
- h = the residual pressure head at the orifice in ft

The formula shown above can be simplified for design purposes by incorporating the discharge coefficient and using conversion factors so that the discharge is given in gallons per minute and the orifice diameter is given in inches. The discharge coefficient depends on the characteristics of the orifice and is usually determined empirically. This value can range from .6 to .8 but a value of .6 was assumed for the purpose of this design aid. The formula therefore simplifies to:

$$Q = 11.79 \, d^2 \sqrt{h}$$

Where:
- Q = the orifice discharge rate in gpm
- d = the orifice diameter in inches
- h = the residual pressure head at the orifice in feet

On the next page Table C-2 gives orifice discharge rates (in gpm) generated using the above formula for various residual pressures (head) and orifice diameters.

TABLE C-2

Orifice Discharge Rates (gpm)					
Head (ft)	Orifice Diameter (in)				
	1/8	5/32	3/16	7/32	1/4
2			0.59	0.80	1.04
3			0.72	0.98	1.28
4			0.83	1.13	1.47
5	0.41	0.64	0.93	1.26	1.65
6	0.45	0.71	1.02	1.38	1.80
7	0.49	0.76	1.10	1.49	1.95
8	0.52	0.81	1.17	1.60	2.08
9	0.55	0.86	1.24	1.69	2.21
10	0.58	0.91	1.31	1.78	2.33

For residuals greater than 10 feet or for orifice diameters greater than 1/4 inch, the equation <u>must</u> be used. This is also true if the residual pressure is not a whole number. For large systems use the equation and verify with Table C-2.

<u>Note</u>: Table C-2 was generated assuming that the minimum residual head at the distal orifice is 5 feet when orifices are 1/8 and 5/32 inch in diameter, and 2 feet for larger orifice diameters.

APPENDIX C-3

FRICTION LOSS DESIGN AID

Friction losses in pipes can be calculated using the Hazen-Williams formula:

Original form: $V = 1.318 * C * R^{0.63} * S^{0.54}$

Where:
- V = velocity (ft/sec)
- C = Hazen-Williams flow coefficient (unitless)
- R = hydraulic radius (ft^2/ft)[1]
- S = slope of energy grade line (ft/1000ft)

This equation can be modified through algebraic substitutions and using unit conversions to yield a formula that directly calculates friction loss[2]:

$$f = \frac{10.46 L Q^{1.85}}{C^{1.85} D^{4.87}}$$

Where:
- f = friction loss (ft)
- D = inside pipe diameter (in)
- L = length of pipe (ft)
- Q = flow (gpm)
- C = Hazen-Williams flow coefficient (unitless)

The Hazen-Williams flow coefficent (C) depends on the roughness of the piping material. Flow coefficents for PVC pipe have been established by various researchers in a range of values from 155 to 165 for both new and used PVC pipe. A coefficient of C = 150 generally is considered to yield conservative results in the design of PVC piping systems.[3]

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[1] hydraulic radius = cross sectional area of the conduit divided by the inner perimeter of the conduit.

[2] Analysis of Pipe Flow Networks, Jeppson, Ann Arbor Science Publications, 1983 (p. 41).

[3] Handbook of PVC Pipe Design and Construction, 2nd Edition, Uni-Bell Plastic Pipe Association, 1982.

The equation shown above can be further simplified by assuming that only PVC pipe conforming to ASTM standard D-2241 (or D-1785 for Schedule 40 pipe) is used. With this assumption, the inside diameters ("D") for the various nominal pipe sizes can be determined and combined with all other constants to yield the following equation:

$$f = L\,(Q/K)^{1.85}$$

Where:

f = friction loss through pipe (ft)
L = length of pipe (ft)
Q = flow (gpm)
K = Constant from Table C-3-1

TABLE C-3-1

Table for Constant "K"

Nominal Pipe Diameter	Schedule 40	Class 200	Class 160
1	47.8	66.5	
1 1/4	98.3	122.9	129.4
1 1/2	147.5	175.5	184.8
2	284.5	315.2	332.5
2 1/2	454.1	520.7	551.1
3	803.9	873.3	920.5
4	1642.9	1692.7	1783.9
6	4826.6	4677.4	4932

Friction loss for some PVC pipe fittings, given in terms of equivalent length of pipe, are provided in Table C-3-2.

TABLE C-3-2

Friction Loss for PVC Fittings[1]

Eqivalent Length of Pipe (feet) PVC Pipe Fittings				
Pipe Size (in)	90^o Elbow	45^o Elbow	Through Tee Run	Through Tee Branch
1/2	1.5	0.8	1.0	4.0
3/4	2.0	1.0	1.4	5.0
1	2.25	1.4	1.7	6.0
1 1/4	4.0	1.8	2.3	7.0
1 1/2	4.0	2.0	2.7	8.0
2	6.0	2.5	4.3	12.0
2 1/2	8.0	3.0	5.1	15.0
3	8.0	4.0	6.3	16.0
4	12.0	5.0	8.3	22.0
6	18.0	8.0	12.5	32.0
8	22.0	10.0	16.5	38.0

[1] From SPEC-DATA, Sheet 15, Plastic Pipe and Fitting Association, November 1994.

APPENDIX C-4

MAXIMUM MANIFOLD LENGTHS

TABLES C-4-1 and C-4-2 can be used to determine maximum manifold lengths for various manifold diameters, given the lateral discharge rate and lateral spacing. The maximum manifold length is a function of lateral discharge rate, lateral spacing, manifold diameter and the roughness of the manifold piping material. Lengths are determined by allowable differences in orifice discharge rates between any two points in the system. These tables were developed to assure that there is no greater than a 15 % difference in discharge rates anywhere in the system.

The distal orifice discharge rate that corresponds to the minimum allowable residual pressure for any given orifice diameter (see Table C-2 in Appendix C-2 for orifice discharge rates) can be multiplied by 1.1 to yield the discharge rate at the proximal orifice of the lateral and by 1.15 to yield the maximum allowable orifice discharge rate anywhere in the system. The residual pressures that correspond to those discharge rates can be calculated by substituting the appropriate discharge rate and orifice diameter for “Q” and “d” respectively into the orifice discharge equation in Appendix C-2 and solving for “h”.

A simplifying assumption was used in calculations to determine the lengths found in these tables. The friction loss that occurs between the manifold and the proximal orifice of any given lateral was considered to be negligible. With this assumption, the residual pressure at the proximal orifice of a lateral can be assumed to be the same as the residual pressure at the point where the lateral joins with the manifold.

The friction loss that occurs across one segment of the manifold (for a given lateral spacing) can be calculated using the simplified friction loss equation and table of constants in Appendix C-3. “L” is the lateral spacing, “Q” is the lateral discharge, and “K” depends on pipe material and diameter and can be found in Table C-3.

This friction loss calculated above can be added to the “end of manifold pressure” and the sum is approximately equal to the residual pressure at a point upstream where the next lateral is connected to the manifold. If this residual pressure is less than the pressure that corresponds to the maximum allowable orifice discharge rate, this procedure is repeated for successive segments, each time adding the discharge of another lateral to the value used for “Q”, until the total head is greater than or equal to the residual pressure that corresponds to the maximum allowable discharge rate. The sum of segments obtained prior to exceeding the maximum residual pressure is the maximum manifold length for a given lateral discharge and lateral spacing.

Maximum manifold lengths were calculated as described above for each pipe material and orifice diameter. Slightly greater manifold lengths were obtained when 1/8 and 5/32 inch orifice diameters with 5 feet of residual pressure at the distal orifice were assumed (see Table C-4-2). These tables were generated assuming Schedule 40 as the pipe material. This material yields the most conservative results (shorter manifold lengths).

TABLE C-4-1

(for orifice diameters of 3/16 in. and up with minimum 2 feet of residual head)

Maximum Manifold Length (ft)																																					
Lateral Discharge Rate (gpm)		Manifold Diameter (inches)																																			
		1 1/4						1 1/2						2						3						4						6					
Central Manifold	End Manifold	Lateral Spacing (ft)																																			
		2	3	4	6	8	10	2	3	4	6	8	10	2	3	4	6	8	10	2	3	4	6	8	10	2	3	4	6	8	10	2	3	4	6	8	10
5	10	4	6	4	6	8	10	6	6	8	12	8	10	10	12	16	18	24	20	22	27	32	42	48	60	34	45	52	72	80	90	72	93	112	144	176	200
10	20	2	3	4				2	3	4	6	8		6	6	8	12	8	10	12	15	20	24	32	30	22	27	32	42	48	60	46	57	72	90	112	120
15	30	2						2	3	4				4	6	4	6	8	10	10	12	12	18	24	20	16	21	24	30	40	40	34	45	52	66	80	90
20	40							2						2	3	4	6	8		8	9	12	12	16	20	12	18	20	24	32	30	28	36	44	54	64	80
25	50													2	3	4				6	9	8	12	16	10	10	15	16	18	24	30	24	30	36	48	56	60
30	60													2	3	4				6	6	8	6	8	10	10	12	16	18	24	20	22	27	32	42	48	60
35	70													2	3					4	6	8	6	8	10	8	12	12	18	16	20	18	24	28	36	40	50
40	80													2						4	6	4	6	8	10	8	9	12	12	16	20	18	21	28	36	40	40
45	90																			4	3	4	6	8	10	6	9	8	12	16	20	16	21	24	30	32	40
50	100																			4	3	4	6	8	10	6	9	8	12	16	10	14	18	24	30	32	40
55	110																			2	3	4	6	8		6	6	8	12	8	10	14	18	20	24	32	30
60	120																			2	3	4	6			6	6	8	12	8	10	12	15	20	24	32	30
65	130																			2	3	4	6			6	6	8	6	8	10	12	15	20	24	24	30
70	140																			2	3	4				4	6	8	6	8	10	12	15	16	24	24	30
75	150																			2	3	4				4	6	8	6	8	10	10	15	16	18	24	30
80	160																			2	3	4				4	6	4	6	8	10	10	12	16	18	24	30
85	170																			2	3					4	6	4	6	8	10	10	12	16	18	24	20
90	180																			2	3					4	3	4	6	8	10	10	12	12	18	24	20
95	190																			2	3					4	3	4	6	8	10	8	12	12	18	16	20
100	200																			2						4	3	4	6	8	10	8	12	12	18	16	20

Instructions: This Table can be used to determine maximum length of a given diameter manifold *or* to determine required minimum diameter for a given manifold length. Known values must include:

1) Manifold - lateral configuration (end or central)
2) Lateral discharge rate "Q" in gallons per minute
3) Lateral spacing in feet

Example A: Central manifold configuration, lateral discharge "Q" = 40 gpm, lateral spacing = 6 ft., manifold diameter = 4 inch; Maximum length = 12 ft.
Example B: End manifold configuration, lateral discharge "Q" = 30 gpm, lateral spacing = 6 ft., manifold length = 18 ft.; Minimum diameter = 3 inch

TABLE C-4-2
(for orifice diameters of 1/8 in. and 5/32 in. with minimum 5 feet of residual head)

Maximum Manifold Length (ft)																																					
Lateral Discharge Rate (gpm)		Manifold Diameter (inches)																																			
		1 1/4						1 1/2						2						3						4						6					
Central	End	Lateral Spacing (ft)																																			
Manifold	Manifold	2	3	4	6	8	10	2	3	4	6	8	10	2	3	4	6	8	10	2	3	4	6	8	10	2	3	4	6	8	10	2	3	4	6	8	10
5	10	6	9	8	12	16	10	8	12	12	18	16	20	14	18	20	30	32	40	30	39	48	60	72	80	48	63	76	96	120	130	100	129	156	204	240	280
10	20	4	3	4	6	8	10	4	6	8	6	8	10	8	12	12	18	16	20	18	24	28	36	40	50	30	39	48	60	72	80	64	81	100	126	152	180
15	30	2	3	4				4	3	4	6	8	10	6	6	8	12	8	10	14	18	20	24	32	30	22	30	36	42	56	60	48	63	76	96	112	130
20	40	2						2	3	4	6			4	6	8	6	8	10	12	15	16	18	24	30	18	24	28	36	40	50	40	51	60	78	96	110
25	50							2	3	4				4	6	4	6	8	10	10	12	12	18	16	20	16	21	24	30	40	40	34	45	52	66	80	90
30	60							2						4	3	4	6	8	10	8	9	12	12	16	20	14	18	20	24	32	40	30	39	48	60	72	80
35	70							2						2	3	4	6			8	9	12	12	16	20	12	15	20	24	24	30	26	36	40	54	64	70
40	80													2	3	4				6	9	8	12	16	10	12	15	16	18	24	30	24	30	36	48	56	70
45	90													2	3	4				6	6	8	12	8	10	10	12	16	18	24	20	22	30	36	42	56	60
50	100													2	3					6	6	8	6	8	10	10	12	12	18	24	20	20	27	32	42	48	60
55	110													2	3					4	6	8	6	8	10	8	12	12	18	16	20	20	24	28	36	48	50
60	120													2						4	6	8	6	8	10	8	9	12	12	16	20	18	24	28	36	40	50
65	130													2						4	6	4	6	8	10	8	9	12	12	16	20	18	21	28	36	40	50
70	140													2						4	6	4	6	8	10	8	9	12	12	16	20	16	21	24	30	40	40
75	150																			4	3	4	6	8	10	6	9	8	12	16	20	16	21	24	30	32	40
80	160																			4	3	4	6	8	10	6	9	8	12	16	10	14	18	24	30	32	40
85	170																			4	3	4	6	8		6	9	8	12	16	10	14	18	20	30	32	40
90	180																			2	3	4	6	8		6	6	8	12	8	10	14	18	20	24	32	30
95	190																			2	3	4	6	8		6	6	8	12	8	10	14	18	20	24	32	30
100	200																			2	3	4	6			6	6	8	12	8	10	12	15	20	24	32	30

Instructions: This Table can be used to determine maximum length of a given diameter manifold *or* to determine required minimum diameter for a given manifold length. Known values must include:

1) Manifold - lateral configuration (end or central)
2) Lateral discharge rate "Q" in gallons per minute
3) Lateral spacing in feet

Example A: Central manifold configuration, lateral discharge "Q" = 40 gpm, lateral spacing = 6 ft., manifold diameter = 4 inch; Maximum length = 18 ft.
Example B: End manifold configuration, lateral discharge "Q" = 30 gpm, lateral spacing = 6 ft., manifold length = 24 ft.; Minimum diameter = 3 inch

APPENDIX D

EXAMPLE

A step by step example of designing a pressure distribution system will be added in a later edition.

APPENDIX E

DETAILED REQUIREMENTS FOR A PUMP VAULT SYSTEM IN A SINGLE COMPARTMENT SEPTIC TANK.

All septic tanks in Washington must have two compartments. However an exception to this is where a pump vault is used. When such systems are used, they shall comply with the following conditions and criteria in addition to all the other conditions and criteria for pressure distribution systems.

1. The minimum storage and pump working volumes in the septic tank must be equivalent to a septic tank with a separate pump chamber. The minimums are a) sufficient volume to handle the functions of a septic tank, and to keep the pump submerged, when required, b) surge volume to hold one day's design flow, and c) additional storage for emergency situations equal to 75% of the surge volume.

2. The pump vault shall have integral to it a screened baffle, with maximum mesh opening of 1/8 inch, minimum wetted open area of 12 ft^2, and that extracts liquid from the middle of the clear zone of the septic tank

3. The pump vault must be designed and constructed to facilitate removal and maintenance of the screen, pumps, and floats.

4. The flow rate from the pump must not exceed 30 gpm. The fluctuation of the liquid level in the tank must not exceed 10 inches. Larger fluctuations are allowed for emergency storage to accommodate power outages or pump failure.

5. The minimum hydraulic detention time in the tank must be 24 hours. The clarified zone must be at least 10 1/2 inches, with a minimum clearance of 3 inches between the bottom of the scum layer and the entrance to the screening device. The minimum distance between the top of the sludge and the entrance to the screening device must be 6 inches.

6. The effluent quality discharged from a pump vault in a single compartment tank must be equal to the expectation for a separate pump chamber that receives screened effluent from a two compartment.

7. Materials and construction must assure a watertight vessel which is resistent to corrosive attack by chemicals and conditions typical for a sewage environment.

8. The minimum size of septic tank must be 1500 gallons as measured at the invert of the outlet. In addition, the lowest liquid level (pump off) shall have a minimum of 1000 gallons, and thereafter coincide with the requirements of WAC 246-272-11501.

APPENDIX F

USER'S MANUAL FOR PRESSURE DISTRIBUTION

A user's manual for the pressure distribution system shall be developed and provided by the system designer at the time that the system installation "as-built" drawing is completed. These materials shall contain the following, as a minimum:

1. Diagrams of the system components and their location.

2. Explanation of general system function, operational expectations, system limitations, owner responsibility, etc. A publicly financed video is available, entitled <u>Understanding and Maintaining Your On-site System.</u>

3. Specifications of all electrical and mechanical components installed (occasionally components other than those specified on the plans are used).

4. Names and telephone numbers of the system designer, local health authority, component manufacturer, supplier/installer, and/or the management entity to be contacted in the event of a failure.

5. Information on the periodic maintenance requirements of the sewage system: septic tank, dosing tank, pumps, switches, alarms, disposal unit, etc.

6. Information on "Trouble-shooting" common operational problems that might occur. This information should be as detailed and complete as needed to assist the system owner make accurate decisions about when and how to attempt corrections of operational problems, and when to call for professional assistance.

8. For proprietary devices included in the system, complete maintenance and operation documents shall be developed and provided by the manufacturer. These documents shall be made available, through the system designer, to the system owner and shall include all the appropriate items mentioned above, plus any additional general and site-specific information useful to the system owner, and/or the maintenance person.

9. Copies of completed warranties.

10. A copy of these documents shall be provided to the local health authority, prior to final approval of the installed system.